Transportation Library

TRAFFIC ENGINEERING & CONTROL

OCT 25 1961
TRANSPORTATION LIBRARY

Vol. 3, No. 6, October 1961 Annual Subscription £2 2s. 0d. Single copies 3s. 6d. monthly

HELPING TO SOLVE BRITAIN'S TRAFFIC PROBLEMS—

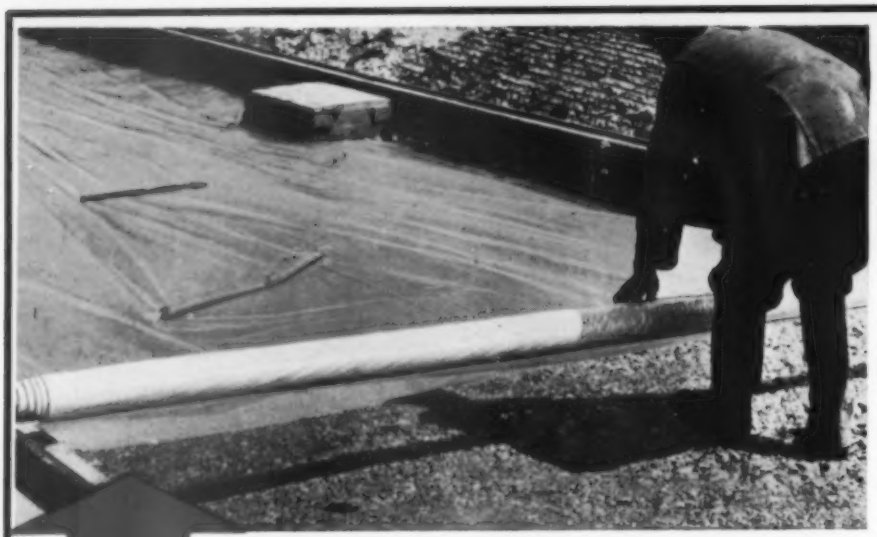
"ELECTRO-MATIC" Vehicle-actuated road signals

Today, local authorities throughout Great Britain are more than ever aware of the potentialities of "Electro-matic" control as the solution to their traffic problems. They are conscious of the versatile qualities of the Type 54 controller, its ability virtually to think for itself under all traffic conditions, and its contribution towards greater safety and confidence. If you have a traffic control problem consult A.T.E. 30 years practical experience is yours for the asking.

ATE

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD. Strowger House, Arundel Street, London WC2. Tel. Temple Bar 9262

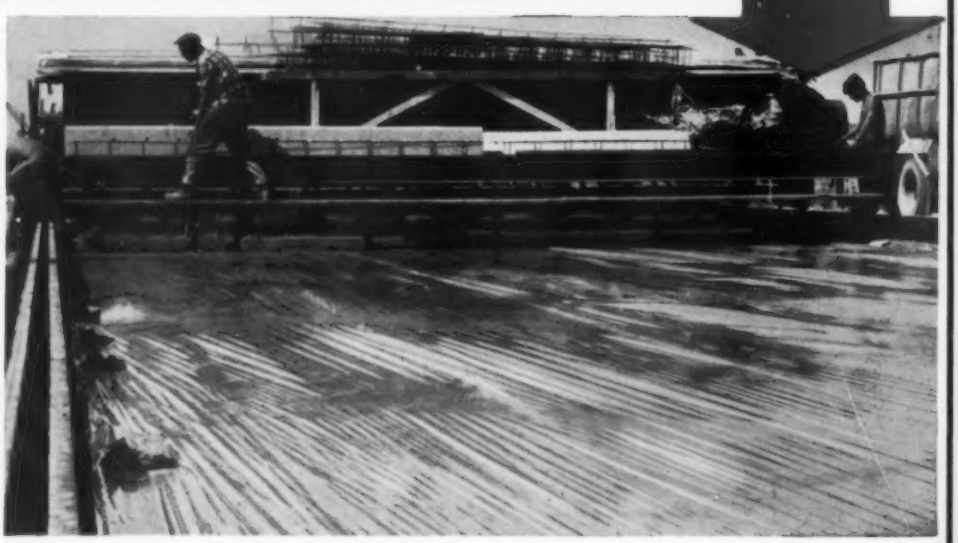
Map. Copyright Hallwag, Switzerland.



'Visqueen' underlay being unreeled *manually*. This can be done from the roll very quickly and with the minimum of effort.

'Visqueen' underlays speed up road construction

whether laid by man or machine



26 feet wide 'Visqueen' sheeting being unreeled *mechanically* on one of the dual concrete carriageways of Contract 2 on the St. Albans by-pass section of the London/Yorkshire motorway.
Agent Authority: Hertfordshire County Council.
County Surveyor: Lt.-Col. C. H. ffolliott, B.A., M.I.C.E., M.I.Mun.E.
Contractors: The Cubitts-Fitzpatrick-Shand consortium.

MORE AND MORE local Authorities are specifying **'Visqueen Building Sheet'** as an underlay for their road building programmes. And it's easy to see why.

'Visqueen' sheeting is quicker to lay and easier to handle—it does not run or shatter, is chemically resistant and completely waterproof. In addition the cost of 'Visqueen' compares favourably with that of conventional underlays and—what is more—considerable economies can be effected if the same sheeting is used first as a curing blanket and then, later, as an underlay.

For major road projects extra-wide seamless 'Visqueen' sheeting can be tailor-made to suit specific bay widths. While, for parkways and service roads, standard rolls up to 12 feet wide (centre folded) are readily available from appointed stockists throughout Great Britain.

To find out how the many applications of 'Visqueen' Building Sheet can help you to cut costs and increase productivity on your contract, write now for an illustrated brochure, price list and samples to:

BRITISH VISQUEEN LIMITED

SIX HILLS WAY, STEVENAGE, HERTS, or telephone STEVENAGE 1310

A Subsidiary Company of Imperial Chemical Industries Limited

BV145

TRAFFIC ENGINEERING & CONTROL

Incorporating TRAFFIC MANAGEMENT

VOLUME 3 No. 6 OCTOBER 1961

The only British monthly devoted exclusively to traffic engineering.

Editor
ERNEST DAVIES

Editorial Advisory Board
SIR WILLIAM G. HOLFORD
SIR WILLIAM BLACK
PROF. W. FISHER CASSIE
WILFRID ANDREWS
CHRISTOPHER T. BRUNNER

Editorial Consultants

Lighting
GRANVILLE BERRY

Parking
CONRAD ANDREN

Signs and Markings
K. SUMMERFIELD

Road Safety
BRIG. R. F. E. STONEY

Industrial News Editor
N. A. KELLY

Advertisement Director
ERIC G. DAVIES

Advertisement Manager
A. G. D. SOAMES

Circulation Manager
E. M. CLARKE

Northern Representative
J. N. ROGERS
24 Ainsdale Drive, Sale,
Cheshire. Tel. Sale 6528.

Traffic Engineering & Control is published by Printerhall Limited, 34-40 Ludgate Hill, London, E.C.4, City 1755/6/7, and printed at The Grange Press, Southwick, Sussex.

The entire contents are protected by copyright in Great Britain and the Universal Copyright Convention, but matter may be reproduced provided that due acknowledgment is made, except for complete articles, in which case application should be made to the Editor.

Annual Subscription £2. 2s. 0d. post free (single copies 3s. 6d.) United States and Canada $7. All other countries £2. 10s. 0d. sterling.

CONTENTS

Editorial Opinion—Washington Conference 341

Topics of the Month 343

FEATURES

Weaving Capacity of Hammersmith Broadway Roundabout . . . 344
D. K. Asproth

Advance Direction Signs and Specular Reflections 347
M. J. Gregsten

Future Urban Traffic Patterns 350
R. Hodgen

DEVELOPMENTS ILLUSTRATED 354

Planning Traffic Intersections. (2) Crossroads and Roundabouts . . 356
Dr.-Ing. Max-Erich Feuchtinger

American Report—Experimental Case Studies of Traffic Accidents . 359

Through Traffic Prohibition Burton upon Trent 361
J. P. Wain and D. W. G. Fretwell

The Trans-Canada Highway 362

Advance Warning for Halted Vehicles 365
Cornelis Kuysten

Lighting Section—Public Lighting in Paisley 367
John Wilson

Street Lighting Over 25 Years 369
H. Carpenter

Profile—Stuart Maynard Lovell 371

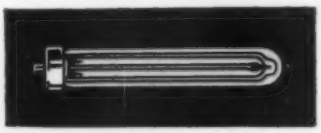
A.P.L.E. Exhibition Report 373

Industrial News 377

TEC645 *for further information*

For *really* good lighting...

In recent years street lighting has made tremendous advances in efficiency. And in the forefront of those advances are Stella Sodium Lamps — shown here in operation at Sheffield. Stella, in fact, offer a range of lamps — both of the Sodium and Mercury types — that provide maximum efficiency in performance together with greater economy. Make your choice Stella — the finest lamp on the road! STELLA — The Reliable Lamp.



Stella

THE RELIABLE LAMP

Lighting installation at St. Mary's Gate, Sheffield. Stella Sodium Lamps are used in Phosco fittings spaced at 120 ft. and at a height of 25 ft. Photograph reproduced by kind permission of J. Woodhouse, Esq., Public Lighting Engineer, Sheffield Corporation.

STELLA LAMP COMPANY LTD · 158/160 SHAFTESBURY AVENUE · LONDON · WC2

The Washington Conference

THREE major lines of thought, of importance to the development of the scope and practice of traffic engineering, emerged from the World Traffic Engineering Conference which met at Washington from August 24 to 26. First, that if the optimum benefit is to be obtained from the growth of motorization, the planning of land use and transport must march together. Second, that if traffic engineering is to make its maximum contribution to planning and movement its scope cannot be confined to roads and traffic but must embrace the whole field of transportation. Third, that the need for increased research on traffic engineering could best be met by international co-operation, and that an organization should be formed for that purpose.

The need for joint planning was the unanimous view of all who prepared papers on 'Urban Transportation and Its Future' and of all who contributed to the open debate irrespective of country—and no fewer than 31 countries were represented at Washington. This view was held generally because of the inter-relation of transport and land use and of the great influence that each has on the other. The general purpose was to prevent uncontrolled urban spread because it inevitably led to the need for increased transport facilities with a consequently greater demand on space both for roads and parking. With predictions before the conference that if present trends continued 85 per cent of the American population would be living in urban areas by 1975, there was general agreement that controlled development was desirable but opinion was divided on how best it could be exercised. It is mainly a question of what kind of a city is wanted in future: 'Megalopolis' —continuous urban conurbations stretching for hundreds of miles with vast populations of many millions—or development of the city on traditional lines with its preservation as a commercial, social and cultural centre. Advocates of both accepted the urgent need for planning based on data obtained from comprehensive studies of present land use, its effect on volume, mode and purpose of transport and sociological trends, studies far more comprehensive than origin and destination surveys, and projected far into the future. This is essentially Britain's need and it was gratifying that Colin Buchanan's assignment to study the long-term transport needs in relation to urban development was commended to the Conference by the General Reporter on the theme, E. H. Holmes of the Bureau of Public Roads, U.S. Department of Commerce. But more extensive and more urgent study will be necesary if Britain is to learn from America's experience and is to escape the worst consequences of urban sprawl and to plan development so that the benefits of motorization are fully turned to the advantage of the city of the future.

From this flows the need to plan transport as a whole and for traffic engineers, working in conjunction with architects, planners and highway engineers, to consider transport needs as a whole so as to try and avoid the worst consequences of urban spread, which leads so often to a deterioration in public transport and in some areas threatens its extinction. It is significant that in America, which has suffered most from this, there are signs of a swing back to public transport, even though as yet it is mainly in the planning and discussion stage. At Washington there were many advocates of rapid transit lines and even of subsidized transport. The deterioration in Britain has not gone nearly as far and decisions on transport planning, as important as those concerning the planning of land use, are urgently required, provided always they are based on data related to future land use, and the two are undertaken jointly.

As regards the need for increased research, it was appropriate that Sir William Glanville, Director of the Road Research Laboratory, was the general reporter for this theme. His summation of the papers, combined with critical comment, was an outstanding contribution. Britain is a leader in this field and its contribution is limited only by the funds the central government provides and the availability of personnel. Although there is already considerable exchange of information between research organizations, it is not systematic and there is overlapping and sometimes insufficient awareness of the research being conducted by different organizations in different countries and of its findings. Already steps have been taken for international co-operation on road safety and consideration is being given to the setting up of an international organization for the purpose. An international organization is also being established for co-operation among road research laboratories, but as yet its scope is limited to the materials and construction aspects of highway engineering. There is no comparable organization for traffic engineering and the need for one was unanimously endorsed.

Although this may prove to be the major achievement of the Washington Conference, the exchange of ideas, which revealed a surprising similarity both of the problems arising in the different countries from increasing motorization and its accompaniment of urbanization, and of the approach to their consideration and solution, evidenced its great value. It is almost certain to lead to a greater appreciation of the contribution traffic engineering can make and an extension of its application, and, not least it is to be hoped, in Britain.

car park FULL

CAR PARK FULL ! . . . the sign that every car park owner wants to put up.

Since the opening, the new municipally owned Bedford multi-storey car park has run smoothly and economically and has repeatedly been filled to capacity, exactly as planned by the Borough Engineer & Surveyor, F.W. Dawkes, B.Sc., A.M.I.C.E., M.I.Mun.E., A.M.T.P.I.

Holst & Company Limited as Civil Engineers are pleased to design to meet your requirements and to create structures that will satisfy your needs.

HOLST

46 CLARENDON ROAD · WATFORD · HERTS.

Telephone: **WATFORD 34481**

BIRMINGHAM MANCHESTER LEEDS DURHAM EDINBURGH CARDIFF

Topics of the Month . . .

THE main debates at the Washington Conference centred on research, urban transportation, interchanges, traffic control on freeways, accidents, and electronics. On the first, there was general agreement on the need for a great increase in the amount of research into traffic engineering and that international co-operation would help this forward, but some disagreement as to the form which co-operation should take. While it was accepted that for this there should be a focal point in each country views differed as to whether it should be an individual, a nationally constituted committee, or a national agency or institute, possibly formed by extending the scope of existing road research laboratories to cover traffic engineering. All agreed that because there was insufficient dissemination of the results of research, and because those engaged in the field were not always aware of what others were undertaking, and because of the desirability of establishing similar standards, any organization set up should be a centre for the collection and distribution of information. Disagreement developed over whether it should undertake research of a co-operative character, and Sir William Glanville, in his general report cited the formula devised for the European Organization for Road Research Laboratories. This provides that the organization would finance only the means by which co-operation in research was affected and that all research of an international character would be financed separately by participants in it. This would seem to be a happy compromise well suited for research in traffic engineering, the more so as it is important that the three bodies contemplated for road research laboratories, road safety and traffic engineering, establish a close relationship to avoid wasteful overlapping and duplication.

Research into Traffic Accidents

THE debate on 'Research into Highway Traffic Accidents' revealed a similarity of experience in regard to the incidence of road accidents in highly motorized countries. There had been a slow but general decrease in the rate of accidents in proportion to vehicle mileage, and in their paper the Road Research Laboratory attributed this to the fact that road users paid more attention, and the authorities punished more severely, in progressive proportion to the increase in the dangers of the road. In all countries where limited access roads had been built, a considerable reduction had been experienced in the rate of accidents in comparison with other roads. Thus in Belgium safety was two to three times greater and in America two and a half times greater. Somewhat surprisingly, in Europe research into accidents on undivided three-lane roads showed them to be not significantly greater than on two-lane roads as had generally been assumed. Stress was laid on the high incidence of accidents resulting from collision with fixed objects along the highway and the need for their careful location and to devise type and designs with a view to their reduction. One of the most comprehensive contributions to the debate came from the Road Research Laboratory and will be published in our November issue.

Motorway Design and Operation

THE debate on motorways highlighted the increasing complexity of linking them with other roads to fulfil the desired aim to feed different capacities into each other with the minimum of conflict. It also evoked considerable discussion of the respective merits of different types of interchanges. Consensus of opinion was decidedly against the roundabout because of its limited weaving capacity and Britain appears to be the only country still clinging to this type of interchange. The clover-leaf seemed to be going out of favour because of its cost and the large amount of land required, although advantages were claimed for it as an interchange between two motorways. The diamond type, with its lengthy diverging acceleration and deceleration lanes, was considered best suited for the link with the existing road pattern and to facilitate traffic flow into it by the use of traffic control devices. There was a plea that minimum design standards should be eschewed because volumes were continually growing and it was more economic to provide for far higher capacities at the time of construction than after saturation was reached.

A.P.L.E. Conference

ALTHOUGH street lighting was not specifically discussed at Washington, its potential contribution to accident reduction was frequently referred to. During the debate on research into accidents, the paper from the Road Research Laboratory stated that lighting was found to reduce accidents by 20 to 30 per cent and Granville Berry, speaking of the relationship between road accidents and lighting, made a convincing case for more adequate public lighting, including that of motorways. This is relevant to this year's Annual Conference of the Association of Public Lighting Engineers, meeting at Scarborough October 3 to 6, and which has special significance because the draft revision of the British Standard Code of Practice is to be discussed at a special session. The Association, therefore, has both a responsibility and an opportunity to make known its views on this important subject. Last year, the Parliamentary Secretary to the Ministry of Transport, brushed aside the plea for further consideration being given to the lighting of motorways and, in view of the further evidence now available of the lives that can be saved and the serious accidents that can be averted by adequate lighting, it is to be hoped that the Association will also not be hesitant in demanding more serious consideration of this aspect of accident prevention.

Weaving Capacity of Hammersmith Broadway Roundabout

Fig. 1. Weaving section A seen towards the north-east. On the left can be seen the parts of the entries to the section which were little utilized.

by **B. K. Asproth,**

Traffic Engineering Division, London County Council.

In this article the results are given of an after study of the capacity of two weaving sections of the roundabout at Hammersmith Broadway, the congestion of which will be relieved when the flyover now under construction is completed. Comparison is made between the actual traffic flows and the theoretical capacities.

THE object of this study is to compare the actual traffic flows on two of the weaving sections of the roundabout at Hammersmith Broadway with the theoretical capacities calculated according to the Road Research Laboratory formula.

The maximum flow through a weaving section is given by:

$$Q = \frac{4.9\,(w + e)\,(4l - 3w)\,(3 - p)}{l\,(0.56 + h)} \text{ veh/h}$$

where w = width of weaving section in feet
e = average of entry widths in feet
l = length of weaving section in feet
p = proportion of traffic weaving
h = proportion of medium or heavy vehicles.

It is proposed by the Road Research Laboratory that 80 per cent of this value of Q should be taken as the practical capacity of a weaving section.

The actual traffic conditions, which were observed in the sections during the traffic counts, will also be discussed.

Owing to the shortage of staff during the traffic counts it was not possible to carry out a complete distribution count, and therefore it has been possible to study only two weaving sections. These two sections are:

A. Beadon Road—Brook Green Road and
B. Hammersmith Road—Great Church Lane (Butterwick).

Traffic counts

A pilot count was taken at the roundabout on August 9, 1960 during one hour in the morning and one hour in the evening. From this count it was learnt that the critical time for section A was during the morning and for section B during the evening peak hour. A morning count was taken of the whole roundabout on October 18, 1960 between 8 a.m. and

9 a.m. The total incoming traffic was then 7,801 vehicles. On the same date a count was taken of the traffic in weaving section B during the evening peak hour, 5-6 p.m. The weather during the counts was fine.

Geometric characteristics

The following are the main geometric characteristics of the two weaving sections:

A. *Section: Beadon Road—Brook Green Road*
w = 64 ft.
e = ½ (54 ft. 6 in. + 36 ft. 6 in.) = 45 ft. 6 in.
l = 145 ft.

In using the formula, it is recommended that the ratio of width to length should not lie much outside the limits of 0.12 to 0.4. In this case, this gives a maximum width of 58 ft. which figure has been used in the calculations.

This weaving section is almost level.

B. *Section: Hammersmith Road—Great Church Lane*
w = 40 ft.
e = ½ (43 ft. + 25 ft.) = 34 ft.
l = 568 ft.

For the same reason as given in A above, the formula gives a maximum length of 480 ft., which figure has been used in the calculations.

The first (northern) half of the section has a slight downward grade, approximately 1:170, and the second (southern) half an upward grade of approximately 1:55. On the right (west) side of the section there are bus stops, separated from the main carriageway by 13 ft. wide islands. The entrance for buses coming from west of the section is at the beginning and the entrance for buses coming from the east is at about 200 ft. down the weaving section. The exit for all buses is at the end of the section.

Observation of traffic conditions

The following observations of the traffic conditions were made during the counts taken on October 18, 1960.

A. *Section: Beadon Road—Brook Green Road*

The entry to this weaving section from Queen Caroline Street (southern entry) was not fully utilized (Fig. 1). Few vehicles used a strip, approximately 10 ft. wide, of the carriageway nearest the left (north-east) kerb. A narrow strip along the right (south-west) kerb of the entry from Beadon Road (north-western entry) was also little used. (These areas are shown hatched on the plan). Taking this into account, i.e., the practical average entry width, approximately 38 ft., and length, approximately 130 ft., of the weaving section were smaller than the theoretical ones, the Q-value of the formula would be reduced by about 14 per cent.

In order to make it possible for pedestrians to cross Beadon Road, that entry to the section was police controlled. The cycle time was about 1 to 1½ minutes and the pedestrian interval about 20 to 30 seconds. This police control probably did not reduce the capacity of the section, since in any case there was a tendency for drivers who intended to weave to enter the section alternately from the two entries. This tendency was probably aggravated by the fact that

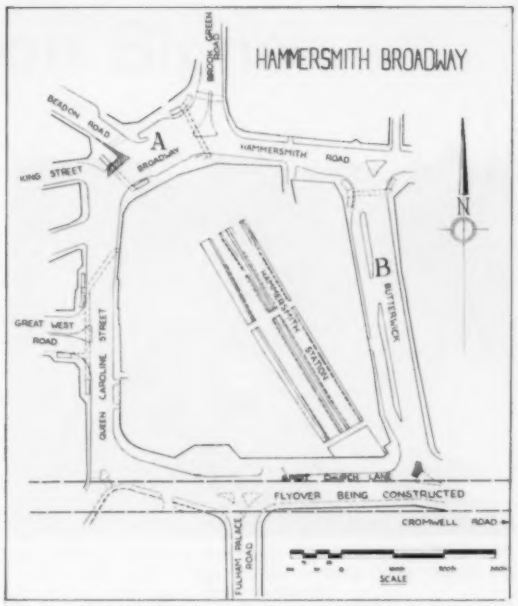


Fig. 2. Plan of the Roundabout.

Beadon Road enters the section at a wide angle, approximately 60°.

The exit from the section towards Brook Green Road was also police controlled because of a pedestrian crossing there. It happened only occasionally that the queue of vehicles in this exit grew so long as to interfere with the traffic in the weaving section. It was, therefore, not thought that this police control reduced the capacity. On the whole, the traffic flowed quite smoothly through this section, but it was felt that its practical capacity was almost reached, at least during the peak quarter of an hour. Some of these conditions are illustrated in Figs. 1 and 3.

Fig. 3. The entries to weaving section A, with Beadon Road to the right. Notice the wide angle between the two entries.

Fig. 4. Weaving section B seen towards north. (Taken from the flyover under construction). Traffic is here able to leave the section freely.

Fig. 5. Weaving section B when traffic is brought to a stop. The queue is here stretching over the whole section.

B. *Section: Hammersmith Road—Great Church Lane*
The entry to this section from Hammersmith Road, was police controlled in order to let pedestrians over to the island (Fig. 4). The entering traffic, however, was stopped only for fairly short intervals. Therefore this control probably had little influence on the capacity of the section. The main part of the weaving manoeuvres seemed to take place within the first third of the section, which confirmed the suggestion that drivers in a weaving section tend to choose their leaving directions as early as possible.

The exit of the section towards Fulham Palace Road, western exit, was police controlled. The traffic from this exit was allowed to proceed alternately with the traffic from Great Church Lane. The cycle time of this control was approximately two minutes. As a result, when the traffic from Great Church Lane was running, a queue was quickly built up in the weaving section. At times of approximately once every five minutes this queue stretched over the whole length of the section and on these occasions its effect could be seen right back at the Broadway, where vehicles were delayed in entering (Fig. 5). In Great Church Lane there was a long queue all the time and the delay was probably considerable.

The width (40 ft.) of the above-mentioned exit was reduced by about 10 ft. because part of the carriageway near the island was under reconstruction. (Shown hatched on the plan).

The exit towards Great Church Lane was also police controlled to allow pedestrians to cross, but as the traffic volume here was rather small, this did not seem to interfere with the flow in the section. It is suggested that the fact that buses coming from Hammersmith Road had to weave in the first part of the section had little influence on the capacity, since in any case most weaving manoeuvres took place in that part. Without doubt, the weak part of this weaving section is the exit towards Fulham Palace Road. Even if it had been possible to utilize its full width, queues would most probably occur at this conflict point. It was felt, however, that if traffic had been able to leave this weaving section freely, the section would have worked quite satisfactorily and probably with some capacity in reserve.

Calculation of theoretical capacities

Section A
During the morning peak hour, 4,776 vehicles passed the section, of which 2,265 were weaving (p = .475). The variation of the flow during the hour was fairly high, the highest quarterly flow being 24 per cent higher, and the lowest quarterly flow being 15 per cent lower than the average quarterly flow.

The proportion of heavy vehicles was 11 per cent.

$$Q = \frac{4.9\,(58 + 45.5)\,(4 \times 145 - 3 \times 58)\,(3 - 0.475)}{145\,(0.56 + 0.11)}$$

$$= 5{,}340 \text{ v.p.h.}$$

Practical capacity = $0.80 \times 5{,}340 = 4{,}270$ v.p.h.

Calculating with the practical average entry widths and length of the section the following values are obtained:

$Q = 0.86 \times 5{,}340 = 4{,}590$ v.p.h.

Practical capacity = $0.86 \times 4{,}270 = 3{,}670$ v.p.h.

Section B
During the evening peak hour, 3,710 vehicles passed the section, of which 2,220 were weaving (p = .60). The variation of the flow during the hour was very small, the highest quarterly flow being 2 per cent higher, and the lowest quarterly flow being 3 per cent lower than the average quarterly flow.

The proportion of heavy vehicles was 12 per cent.

$$Q = \frac{4.9\,(40 + 34)\,(4 \times 480 - 3 \times 40)\,(3 - 0.60)}{480\,(0.56 + 0.12)}$$

$$= 4{,}800 \text{ v.p.h.}$$

Practical capacity = $0.80 \times 4{,}800 = 3{,}840$ v.p.h.

(*Concluded on page* 353)

Advance Direction Signs and Specular Reflections

by **M. J. GREGSTEN,** *Road Research Laboratory*

In this article the association between specular reflection and the alignment of signs is discussed, and the results are given of experiments to determine the alignment required to avoid specular reflection from the smaller direction signs in use on all-purpose roads. The article was received before the Author's tragic death.

THE legibility of advance direction signs can be seriously impaired at night by specular, i.e. mirror-like reflection of the light from vehicle headlamps (Fig. 1 (a)). In a recent survey of some 300 signs situated on major trunk roads, nearly half were found to exhibit some degree of specular reflection. Similar observations were made on the large signs on the Preston motorway in 1959[1], and in this case specular reflection was observed only on a sign on a left-hand bend. Measurements of the alignment of these signs, and of seven serious cases on route A30, showed that whereas the motorway signs had flat surfaces and were aligned substantially at right angles to the carriageway, those on the all-purpose road all showed some degree of surface irregularity and were turned towards the oncoming traffic by angles of up to 10°. It appears to be the general practice to align direction signs in this way.

Conditions Causing Specular Reflection

Consideration of the geometry of the situation shows that if a sign is perfectly flat, specular reflection should occur only when it is turned towards the oncoming traffic. It may, however, be observed on signs aligned at right angles to the road if the surface of the sign is not flat.

Fig. 1 (*a*). *Specular reflection from a sign aligned perpendicular to the carriageway.*

Fig. 1 (*b*). *The same sign viewed from the same position but turned away from the observer through an angle of* 5°.

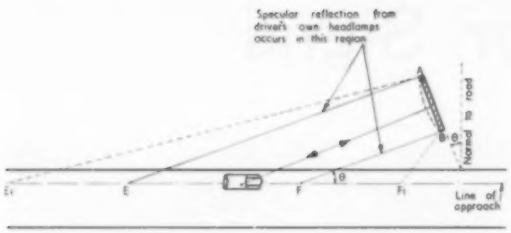


Fig. 2. The cause of specular reflection—straight road.

Fig. 2 shows a plan view of a straight section of carriageway, with a sign AB turned towards the oncoming vehicle through an angle θ. Assuming for simplicity that while reading the sign, the driver's line of sight is coincident with those parts of the headlamp beams illuminating the sign, specular reflection will occur in the region where the vehicle's path is intersected by normals drawn from any point on the surface, i.e. in the region EF. This region will be extended if the sign face is convex, as shown by the dotted outline, or shows other surface irregularities, as indicated at E_1F_1. In addition, it may be noted that specular reflection could be due to light from the headlamps of a preceding or following vehicle. If the distance at which it is just possible to read the lettering on the sign (the legibility distance) falls within the region E_1F_1 specular reflection will hamper the driver's recognition of the message.

Elimination of Specular Reflection

From the foregoing it can be seen that specular reflection could be avoided by so positioning the sign that normals drawn from all points on the surface, taking into account convexity and other irregularities, either do not intersect the vehicle's path, or do so beyond the legibility distance of the sign. Tilting the sign slightly upwards, as favoured in Germany, poses difficult erection problems, and will not work on down-gradients unless the sign is tilted an additional amount equal to the slope of the road. This objection does not arise, however, if the sign is turned away from the oncoming traffic in the horizontal plane through a small angle, φ in Fig. 3 (a). No account need then be taken of vertical gradient, since any incident headlamp beam will be returned in a direction away from the driver's eyes. The effect of turning the sign in this way is shown in Fig. 1 (b).

A sign situated on a left-hand bend would require a greater value for φ than one on a straight road, since it is in effect already turned further towards a driver approaching it round the bend. Fig. 3 (b) illustrates this situation, from which it can be seen that the angle φ should be measured relative to the normal to a chord joining a point on the carriageway adjacent to the sign to another point in advance of the sign at a distance equal to or greater than the legibility distance. With the sign aligned in this way, the region in which specular reflection could take place will lie entirely in advance of the point at which the sign becomes clearly legible. Expressions can be derived for the equivalent additional amount of turn required (relative to the normal to the carriageway), based on the curvature of the bend. Very approximately these are ¼ degree per in. of letter height per degree change of curvature in 100 ft., or $\frac{3h}{2r}$ degree where r is the radius of curvature in thousands of feet and h the letter height in inches, assuming a legibility distance of 50 ft. per in. of letter height. As a result of preliminary discussions on this subject, and an examination of the positioning of the signs on the Preston By-pass, the signs on the M1 motorway were aligned between 2° and 4° away from oncoming traffic. The result was most successful: no specular reflection has been observed and motorists do not notice that signs are turned away. As already mentioned, motorway signs are generally flatter than signs on all-purpose roads, so that the latter may need a larger rotation to avoid specular reflection and this has now been investigated.

Alignment Angle on All-purpose Roads

Two experiments were carried out to determine the alignment angle φ appropriate to signs used on all-purpose roads. One was a laboratory experiment, the other was carried out on route A30 on existing signs.

In the first experiment six advance direction signs recently taken out of service were set up, in turn, in a vertical plane at the edge of an experimental roadway. Each sign was observed in darkness from a vehicle driven slowly towards it from a distance of 150 ft. The height of the sign and displacement from the observer were 3 ft. and 4 ft. 6 in. respectively, representing the worst situation likely to be encountered on the road. As the test runs were made each sign was turned progressively away from its initial position at right angles to the road in a direction away from the observer until all trace of specular reflection was removed. The final angle of alignment was measured, taking the line joining the vertical supports as defining the plane of the sign. The results of this test, gave a maximum value for φ of 4° for a stove-enamelled sign mounted on a wooden frame, a popular form of construction.

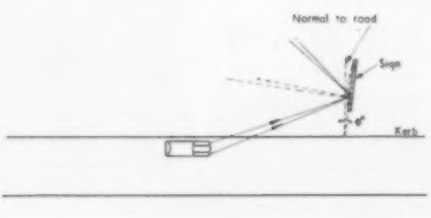


Fig. 3 (a). The elimination of specular reflection—straight approach.

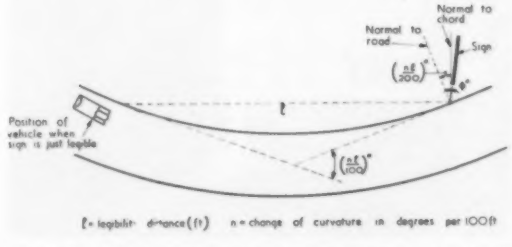

Normal to chord
Normal to road
Sign
Position of vehicle when sign is just legible
l = legibility distance (ft)
n = change of curvature in degrees per 100 ft

Fig. 3 (b). The elimination of specular reflection—left hand approach.

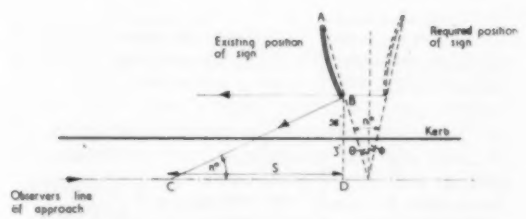
TABLE I

Amount by which existing signs on route A30 should be turned outwards to eliminate specular reflection (See Fig. 4)

Form of construction of sign	*Dimensions* Width	Height	*Distance at which specular reflection disappeared* S (*ft.*)	*Distance of near edge of sign from kerb* x (*ft.*)	*Total distance of sign from observer* (*ft.*)	*Existing alignment angle* θ (*deg.*)	*Angle between line of approach and normal to sign* n (*deg.*)	*Required alignment* $\varphi (= n - \theta)$ (*deg.*)
Stove enamel	3 ft. 10 in.	× 2 ft. 8 in.	46.3	5 ft. 1 in.	8 ft. 1 in.	5	10	5
White panels on yellow	6 ft. 10 in.	× 5 ft. 2 in.	31.7	2 ft. 2 in.	5 ft. 2 in.	5½	9½	4
White panels on yellow	7 ft. 2 in.	× 5 ft. 2 in.	42.6	2 ft. 2 in.	5 ft. 2 in.	2½	7	4½
White panels on yellow	5 ft. 10 in.	× 5 ft. 4 in.	96.0	5 ft. 5 in.	8 ft. 5 in.	3	5	2
Stove enamel	3 ft. 0 in.	× 2 ft. 8 in.	50.1	7 ft. 3 in.	10 ft. 3 in.	8	11½	3½
Stove enamel	3 ft. 10 in.	× 2 ft. 6 in.	51.8	8 ft. 0 in.	11 ft. 0 in.	7½	12	4½
Stove enamel	3 ft. 0 in.	× 2 ft. 6 in.	48.4	6 ft. 3 in.	9 ft. 3 in.	6	11	5

These measurements were confirmed by observations on signs in existence on the A30 route. The signs were approached at night, at a speed of 30 mile/h, keeping a constant distance from the kerb, and recording the distance from each sign at which specular reflection completely disappeared. The observer was in the front passenger seat, and care was taken that no other vehicle was travelling in the same direction in the vicinity of the sign at the time of the measurements. The existing alignment of the signs was recorded; this is tabulated in Table I together with the results of the specular reflection measurements.

The method of calculating the required angle of re-alignment is shown in Fig. 4, the results of the calculations being included in Table I. These tests gave a maximum value for φ of 5°, again for a stove-enamelled sign on a wooden frame.



n = Angle between line of approach and incident and reflected light at point where specular reflection disappears.

x = Distance of near edge of sign from kerb (ft.).

S = Distance of observer from sign when specular reflection disappears.

G = Existing alignment angle.

Q = Required angle of alignment to project normal to sign at edge down a line parallel to road.

$$\text{Whence } n = \tan^{-1}\frac{x - r\,3}{S}$$

$$\text{And } \varphi = n = \theta$$

Fig. 4. Method of calculation of re-alignment required to eliminate specular reflection from existing signs.

It has been shown that specular reflection can occur if a sign of which the surface is not perfectly flat is either turned towards or at right angles to the road, and that the simplest method of avoiding this is to turn the sign slightly away from the oncoming driver. Two experiments to determine the necessary angle gave values of 4° and 5° respectively. The probable reason for the difference is that whereas in the laboratory the tests were carried out over a finite observation distance, the calculations in the second experiment refer to the removal of specular reflection at all distances. The difference is so small, however, as are the angles involved, that it is reasonable to take the figure of 5° as being the required angle.

Recommendations

(1) All advance direction signs, whether illuminated or not, should be aligned in a vertical plane and turned away from oncoming traffic.

(2) The angle of turn-out should be 3° ± 1° for motorway signs, and 5° ± 1° for signs on all-purpose roads.

(3) On straight roads and right-hand bends the angle of turn-out should be measured from the normal to the carriageway.

(4) On left-hand bends the angle of turn-out should be measured from the normal to a chord of length equal to the legibility distance, reckoned at the rate of 50 ft. per in. of letter height, drawn back from the sign.

ACKNOWLEDGMENTS

The work described in this article was carried out as part of the programme of the Road Research Board of the Department of Scientific and Industrial Research. This article is published by permission of the Director of Road Research.

REFERENCE

[1]The Alignment of Motorway Direction Signs. Advisory Committee on Traffic Signs for Motor Roads. CTS 13, August 1959.

FUTURE URBAN TRAFFIC PATTERNS

by **R. HODGEN,** *M.Sc., A.M.I.C.E.*

The author recently presented a paper on 'Estimating Future Traffic Patterns in an Urban Area' at a course on Traffic Engineering run by the Scottish Branch of the Institution of Municipal Engineers, from which this article has been prepared by Mr. Hodgen, Traffic Engineer with Scott & Wilson, Kirkpatrick & Partners, Consulting Civil and Structural Engineers.

DURING the past 15 years more than 100 cities in the United States have carried out comprehensive traffic studies. More recently there has been a growing interest in this subject in Great Britain. In general, such studies are undertaken when new highway proposals of an urban motorway nature have been made or are under consideration and it is necessary to collect traffic data to justify the need for, and to assist in the design of, these facilities. Motorways, once constructed, are likely to be in use for many years to come, particularly in an urban area where land values are high and any form of disturbance is always costly. If then, they are to be of lasting value, they must accommodate not only the current traffic, but that which is likely to develop during their probable service life. A comprehensive traffic study is concerned, therefore, not only with the measurement of an existing situation but with its projection into the future. The future will be determined not only by the overall growth in traffic but also by the changes in the distribution of population and of land use. The purpose of these notes is to review some of the published methods which have been used to synthesize a future traffic pattern from an origin and destination survey of existing traffic, planning and economic studies of present and future land use, and the growth of vehicular traffic.

Comprehensive Traffic Study

The principal stages of an urban traffic study and their relation to each other are shown diagramatically in Fig. 1.

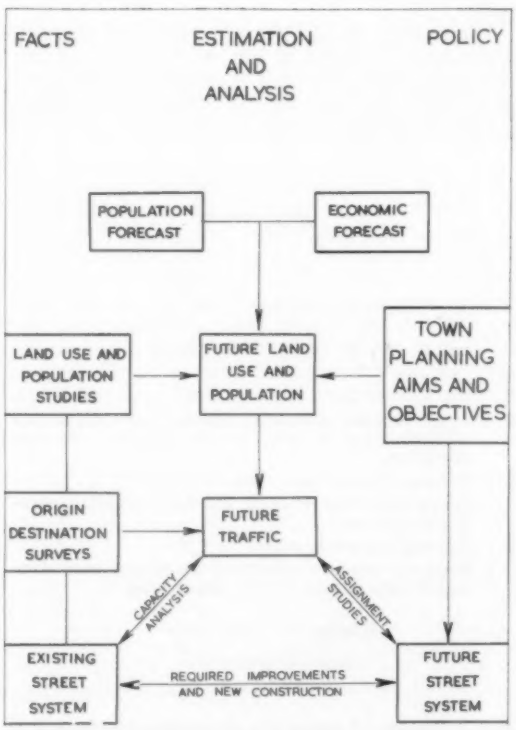


Fig. 1.

It is presumed that the following stages of the study will have been completed:

(1) The study area will have been defined and subdivided into traffic zones. The area is designed in such a way that it will include the probable future of 'design year' limits of urbanization. This zoning will be in considerable detail and may be taken to require some hundreds of zones.

(2) A comprehensive origin and destination survey will have been carried out and the results coded to the chosen zoning system and tabulated. At least one punch card will have been prepared for each zone to zone combination and possibly more than one to cover each of several vehicle type and trip purpose classifications.

(3) Population and land use data will have been collected and related to the traffic zones which subdivide the study area. This data will probably be best collected by or in collaboration with the local planning agency. For this reason alone the traffic zoning should be reviewed by the planners who undoubtedly will already have relevant information available on their files. The information available, or which can readily be collected, may well have a considerable bearing on the methods of projection to be used, as discussed in more detail later.

(4) The planning data will have been projected to the year for which the traffic projection is to be made.

(5) A projection of the overall growth in vehicular travel for the study area will be available. This is, of course, the most important, most controversial and most difficult of all the figures to be decided. The best determinant would appear to be based upon vehicle registeration in the study area. This is based upon the assumption that while congested conditions may have repressed traffic growth in particular parts of the study area, the extent of the congestion is unlikely to have as yet inhibited the growth in vehicle registration. A study of mileage per vehicle on a national basis here and abroad indicates that the changes in mileage per vehicle are marginal compared to the change in the total number of vehicles. It follows that, except where congestion is used as a method of repression, the growth in registration will closely reflect the probable growth in traffic.

The object is now to reconcile the present traffic pattern, the overall growth rate and the differential growth of individual areas into a future traffic pattern. The available methods fall into two broad groups. These are the 'growth factor' and the 'analytical' approaches.

Growth Factor Methods

The oldest and simplest method is to develop a single figure for growth to be applied to the current traffic pattern for the entire study area. While this method has the great advantage of simplicity, a study of the projected population movements for the next 20 years in the great urban areas shows that it does over-simplify the picture.

In Glasgow for instance, it is anticipated that redevelopment projects will displace some 200,000 people from the city. At the same time the planning authority of virtually every suburban area bounding on Glasgow is anticipating a population increase, some of which will more than double the present population. It seems only reasonable, therefore, that if a comprehensive survey of some magnitude is to be undertaken at very considerable expense, some attempt should be made to allow for such known patterns of differential growth. The simplest method which will still make some allowance for differential growth is the 'average growth factor' method. In this the overall growth factor for the area is modified by the individual changes projected in each zone to derive a 'growth factor' for each zone. The predicted

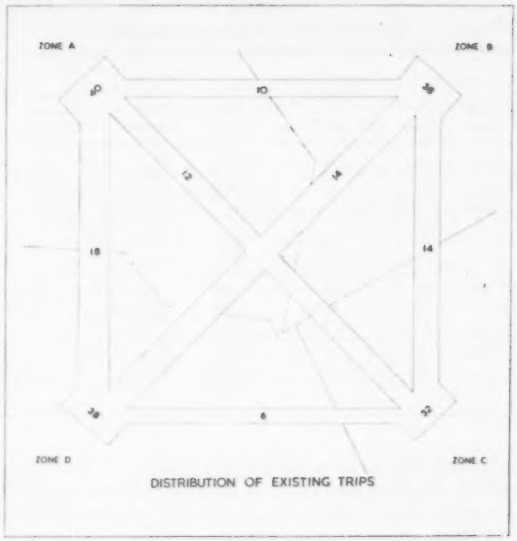


Fig. 2.

increase of the volume between any two zones is then the average of the growth factor of the two zones concerned. To illustrate this method it was applied to the example shown in Fig. 2. The calculations are shown in Table I. It will be observed that the final result does not balance.

A method developed for the Cleveland Survey by Mr. T. J. Fratar introduced two new ideas. The first was to modify the growth of trip volumes from Zone A to Zone B by the interchange between Zone A and all other zones. This modification is contained in the formula

$$G_A V_A \frac{G_B v_{AB}}{\Sigma G_X v_{AX}} = \text{Future Volume from A to B}$$

Where

G_A = the growth factor of Zone A

V_A = the current total of trips ending in Zone A

v_{AB} = the current volume of trips between Zones A and B

Table II shows the calculations for this method applied to the example shown in Fig. 2. It will be observed that two answers are obtained for each interzonal interchange. These are averaged to give

TABLE I

Average Growth Factor Method—First Approximation

From Zone	*To Zone*	*Average Growth Factor*	*Current Trips*	*Future Trips*	*Final Growth Factor*
A	B	2.5	10	25	$\frac{80}{73} = 1.1$
	C	1.75	12	21	
	D	1.5	18	27	
B	A	2.5	10	25	$\frac{114}{84.5} = 1.3$
	C	2.25	14	31.5	
	D	2.0	14	28	
C	A	1.75	12	21	$\frac{48}{60} = 0.8$
	B	2.25	14	31.5	
	D	1.25	6	7.5	
D	A	1.5	18	27	$\frac{38}{62.5} = 0.6$
	B	2.0	14	28	
	C	1.25	6	7.5	

TABLE II

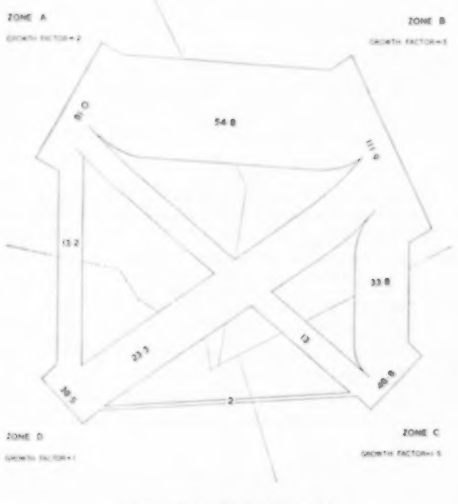
Fratar Method—First Approximation

From Zone	*To Zone*	*Current Trip Volume × Growth Factor*	*New Trip Volume*	*Average New Trip Volume*	*Final Growth Factor*
A	B	30	36.4	39.0	80
	C	18	21.8	18.9	— = 1.04
	D	18	21.8	18.8	76.7
B	A	20	41.5	39.0	114.0
	C	21	43.5	35.7	—— = 1.16
	D	14	29.0	23.6	98.3
C	A	24	16.0	18.9	48.0
	B	42	28.0	35.7	—— = 0.82
	D	6	4.0	4.0	58.6
D	A	36	15.8	18.8	38.0
	B	42	18.3	23.6	—— = 0.82
	C	9	3.9	4.0	46.4

the new trip volume recorded in Table II. However, when the trips out of each zone are added up there is again an unbalance or, if one likes, a new growth factor.

The second new idea was to treat the results of the first calculation as if it were indeed a new set of trip interchanges and growth factors. This sets up a series of successive approximations which can be halted when the new growth factors finally achieved are satisfactorily close to unity.

It will be seen that the second of the two ideas can equally be applied to the average factor method since it also ends up in an unbalanced state after the first approximation. This was again applied to the example shown in Fig. 2 and both methods were carried to the third approximation. The results of these calculations are shown in the form of modified growth factors in Table III. The new trip distribution pattern as obtained by the third approximation of the Fratar method is shown in Fig. 3. The Fratar method is closer to closure both after the first and third approximations so that it involves less calculation.



DISTRIBUTION OF FUTURE TRIPS

Fig. 3.

TABLE III

Zone	*After First Approximation*		*After Third Approximation*	
	Fratar	*Average Factor*	*Fratar*	*Average Factor*
A	1.04	1.09	0.98	1.06
B	1.16	1.30	1.04	1.18
C	0.82	0.80	0.97	0.83
D	0.82	0.60	0.98	0.74

It will be appreciated from the large volumes of individually simple calculations involved in these approximations that the methods lend themselves very readily to the use of computers. A test similar in principle to the very simple one shown here was applied to the results of an actual comprehensive survey by computer methods. This evaluation was reported in *Public Roads*, a publication of the Bureau of Public Roads, in October, 1958. It was concluded there that the Fratar method reached closure much faster than either of the other methods. There seems therefore no doubt that of the growth factor methods the Fratar method is the best available tool for this problem.

Analytical Methods

A more theoretical approach to the problem has been attempted in some recent studies. This approach can be considered in two sections. The first is trip generation, and the second trip distribution. That is, given a specific type and amount of land use, how many trips will be made from it and where will they go. Information as to this can initially only be derived from the existing situation, and the studies both of traffic and planning data must necessarily be very comprehensive and detailed to justify the additional work involved in the more theoretical approach. For instance, it is not reasonable to expect the same laws to govern trips between home and work as those made for pleasure. Nor is it reasonable to expect that a wealthy residential suburb with a high percentage of car ownership can be correlated with a densely developed, low income, city housing area.

As a minimum, the development of rates of trip generation will require to be based upon the types of detailed trip information which can most reasonably be collected by door to door interview methods. Information on income level or social standing and on levels of car ownership will be required. A very detailed study of non-residential land use is essential if it is to be successfully correlated with trip generation and many different types of classification will be required since, for instance, trip generation levels will vary quite widely between different types of industrial development. In this connection it is rather interesting to speculate to what degree the 'home interview' methods developed in the United States would require modification because of the higher percentage of business travel in this country. In America it has been estimated that about 80 per cent of the trips made in a typical urban area will begin or end in the home. One would imagine that this percentage would be somewhat lower in Great Britain.

It is self evident that trip distribution will roughly be controlled by opportunity and distance. For instance, in choosing a home one is likely to balance the most desirable location against the distance from

one's place of employment. There are equally obviously many other factors—habit perhaps being the one which most readily comes to mind. However, it has been claimed that satisfactory correlation can be obtained by a relatively simple classification of trip purpose and a generalized description of opportunity. The actual mathematical models employed to describe theprocess of trip distribution have received considerable attention but no general agreement has as yet been reached on the most suitable of these, nor on the most suitable parameter to describe distance and opportunity. Thus although theoretically the most suitable distance parameter is cost, in practice time has been more widely used. An interesting discussion on trip distribution models has been reported in an American publication *Highway Research Board Bulletin* 253, 1960.

One may well ask why bother with these methods at all since they call for a great deal more work than the growth factor approach. A number of advantages can be claimed for them. Perhaps the more salient of these are:

(1) Allowances can be made for radical changes in accessibility which may be expected to alter existing traffic patterns. The case of a completely new river crossing at some distance from any previously existing crossing is an extreme example of this type. In the case of growth factor methods the only solution is to make an empirical allowance.
(2) Allowance can be made for radical changes in development such as a completely new residential area developed on presently vacant land. Again, such matters must be adjusted empirically in the growth factor method.
(3) The development of general or average relationships from existing data will have a 'smoothing' effect on the erratic results which are to be expected in the prediction of small trip volumes due to the sampling methods adopted in O-D surveys. Again, this is of most importance where a larger than average increase is expected in a particular area and is analogous to the previous case of new development on vacant land.
(4) The development of these relationships are of particular value when a hypothetical situation has to be forecast as for instance in the case of a new town.

Summary and Conclusions

The best estimate of a future traffic pattern for an urban area requires as a minimum:

(1) A comprehensive O-D. survey which will attempt to sample all vehicular movements on an average day in the study area.
(2) A careful study of the existing distribution of population and land use and a projection of future trends in development.
(3) A projection of the increase in vehicular traffic.

The combination of these studies and surveys into a future traffic pattern can be achieved by many methods but these fall into two basic groups. The first is the growth factor method. This makes an empirical projection of the present pattern based on 'growth factors' which are estimated for each zone from the changes of land use predicted for the zone and the general growth in traffic. Of such, the most useful is generally agreed to be the Fratar method. Several computer programmes have been written, tested and used for this method and are available as library programmes. The second group is the analytical method. This requires a more detailed study. To justify its use a door to door interview method of O-D survey and elaborate planning and economic studies, which will enable realistic correlations to be made for trip generation and distribution, are required. To offset the greater elaboration of this type of study it can lead to a better understanding of the build-up of traffic and indeed the entire transportation system. However, the cost is high and difficult to predict, as the methods are in a relatively early stage of development.

The choice as between the one or the other of these groups will be dependent upon the object of the study and the time, staff and funds which are available. In making the decision, however, it is most necessary that one should be realistic. One of the pitfalls of traffic studies is the ease with which elaborate studies can be made to produce incorrect results.

REFERENCES

[1]Fratar, Thomas J. 'Vehicular Trip Distribution by Successive Approximations'. Traffic Quarterly, January 1954—Eno Foundation.
[2]Brokke, G. E. and Mertz, W. L. 'Evaluating Trip Forecasting Methods with an Electronic Computer'. Bulletin 203—Highway Research Board.
[3]Lynch, John T. et al. 'Panel Discussion on Inter-Area Travel Formulas'. Bulletin 253—Highway Research Board.

Hammersmith Broadway Roundabout—*concluded from page* 346.

Conclusions

The following conclusions have been drawn from this study:

In section A the practical capacity, calculated according to the Road Research Laboratory formula, was exceeded by approximately 12 per cent when using the actual entry widths and length of the section. If the practical entry widths and length were used, the practical capacity was exceeded by approximately 30 per cent, i.e., the Q-value was exceeded by approximately 4 per cent. This despite the fact that it was only during the peak quarter of an hour that it looked as if the weaving section was loaded to its practical capacity. A reason for this fact might have been that the weaving traffic entering the section did so alternately from the two entries during most of the time. In this case the entry widths would be the decisive factors.

In section B the practical capacity was almost reached according to the formula. The observed conditions during the intervals when traffic could leave the section freely seemed to agree with this fact fairly well. Congestion occurred, however, when traffic was stopped at the south-western exit.

The traffic conditions at section B emphasize the fact that, in order to obtain full working capacity without congestion occurring, it is of utmost importance that traffic should be able to leave the weaving section freely.

Explanatory note

A flyover between Cromwell Road and Great West Road is now being constructed. It has been estimated that this flyover will reduce the flow in weaving section A by about 1,050 v.p.h. (non-weaving) during morning peak hours and the flow in weaving section B by about 500 v.p.h. (weaving) during evening peak hours.

ACKNOWLEDGMENTS

The author is indebted to Mr. Joseph Rawlinson, C.B.E., M.Eng., M.I.Mun.E., M.I.C.E., M.I.Mech.E., Chief Engineer and County Surveyor, London County Council, for permission to present this Paper; the opinions expressed in the Paper are, however, those of the Author and do not necessarily reflect the views of the London County Council or of the Council's Chief Engineer.

An Order, understood to be the first of its type to be confirmed by the Ministry, has recently been passed to prohibit through traffic using the two streets in the Town Centre of Burton upon Trent. The photograph on the left shows congestion in the High Street before enforcement.

Developments

Motorists on a four mile stretch of Mound Road Warren, Michigan, U.S.A. are advised by these overhead signs of the correct speed at which they must drive to arrive at the next set of traffic signals during the green phase. The system has been developed by General Motors Research Laboratories.

The bridge shown below crosses the Thames at Bray, Berkshire, and forms part of the newly constructed Maidenhead By-Pass, which was opened to traffic on June 26.

A view of the High Street, Burton upon Trent, after through traffic was prevented from using it. Since alternative routes are available, the streets have been closed to vehicles not needing to pass through the centre. Full details of this scheme are to be found on page 361.

Illustrated

Work on the construction of the Queensferry By-Pass was begun in August 1960 and is now nearing completion. This photograph shows the construction in progress on this important road which will link the large conurbations of Lancashire and the Midlands with the holiday resorts of North Wales.

A second view of the Queensferry By-Pass. Heavy commercial traffic from the industrial areas will use this road which will have hot rolled asphalt base and wearing courses.

Fig. 1. Neu-Ulm, Memminger-Strasse-Ring-Strasse (Allgäuer Ring) Intersection.

Planning Traffic Intersections

Dr.-Ing. Max-Erich Feuchtinger

2. Crossroads and Roundabouts

This is the second article in a series of five containing extracts from the last published work of the late Dr.-Ing. Max-Erich Feuchtinger. They have been compiled and translated by Arthur Henderson, Consulting Traffic Engineer.

CROSSINGS at grade are naturally the simplest and most common forms of highway intersection. The flow of the traffic inside the intersection is regulated either by the principles of right-of-way regulations, which can be in varied forms (the first into the intersection has the right-of-way; or the vehicle entering from the right, or the left, has the right-of-way; from regulations controlled by the use of signposting and marking; or with the use of Stop signs; or, as is common practice in the United States, with Stop signs on all four entering streets); alternatively, the manoeuvring room of traffic can be so arranged that traffic is regulated by policeman or signal installations.

The fundamentals for the design of crossroad intersections on the open country highway and the city street networks are well known[1,2] also the calculation method for their dimensioning[3,4]. It is therefore not necessary to bring normal daily planning examples into this discussion. But there are certain special types of crossroad intersections that are worth examining, and crossroad intersections on multi-levels will be considered in succeeding articles.

Hanover: Klingerplatz Intersection

The old and always renewed question: 'Crossroads or Roundabout?' is put almost daily to the traffic engineer. During the early days of motorization development there was always more or less intuition in the handling of this problem, but, in the meantime, knowledge of the capacity and safety of intersections has vastly increased—so that today we can put forward solutions with the help of traffic studies calculated in volume and density. This experience leads us more and more to the conclusion that it is not a question of 'Crossroads or Roundabout'—but rather 'Crossroad Intersection with Roundabout'. This means that the principles of both are valid for the good design of intersections—so that the traffic planner must be aware of when and under what special circumstances one or the other form has its practicability. The best solutions are often only found after parallel studies with both types of intersection. The individual solution depends very greatly on the local conditions for the best form of the intersection to be arrived at. It is quite false to choose one or other type of intersection according to fixed rules. The local situation and conditions dictate more individual solutions.

An example of such a parallel study is found in Hanover (570,000 population) at the Klingerplatz Intersection. It lies on Hanover's most heavily loaded main exit highway in the direction of Hamburg and Berlin (Autobahns). The intersection has been signal controlled for a long time but it has not accomplished its main purpose—not to direct the inflowing traffic straight ahead into the City centre, but along the tramline route on to the East Tangential Highway, Klinger-Strasse, running in the north-south direction. Moreover, in detail the intersection is insufficiently constructed for its purpose.

Accordingly, in 1955, the city of Hanover carried out a traffic study to find out whether alterations to the traffic at the intersection could be achieved better through the principles of roundabout or crossroad. A preliminary solution that looked satisfactory had already been prepared by the city of Hanover (Fig. 2). This had the intention of diverting the traffic from

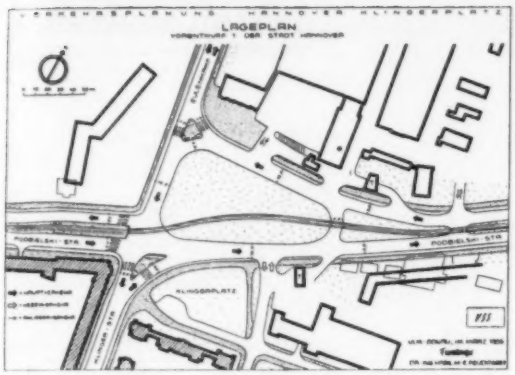


Fig. 2. Hanover, Klingerplatz: Preliminary design based on Roundabout principle—as proposed by the City of Hanover.

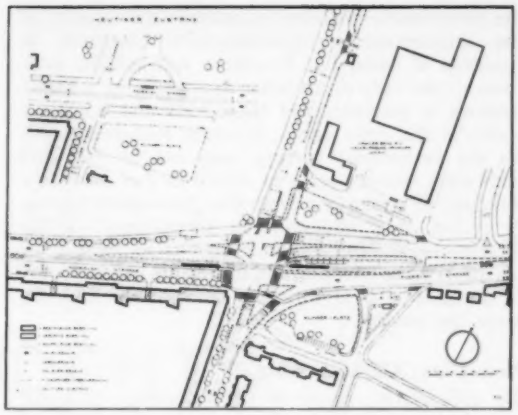


Fig. 3. Hanover, Klingerplatz: Original condition of the intersection—inset top left—and the design adopted based on Traffic Analysis and Diagnosis.

the main inflow of Podbielski-Strasse into Klinger-Strasse South. The traffic calculations showed, however, that a signal installation was necessary even with the then 16-hour traffic count of 20,000 passenger car units passing through the intersection—especially in view of the crossing traffic streams (Klinger-Strasse North-South, and the Podbielski-Strasse West-East, along with the tramway). Thereby, the main advantage of the roundabout principle was lost. Expressed in another way, when signalization is necessary the extra length of detour over the roundabout is saved for the inflowing traffic; it can be led through direct along the shortest route, and the special handling of the left-turning traffic into Klinger-Strasse can be achieved by correct time-factor setting in the signal-phasing.

The crossroad solution (Fig. 3) resulted out of further studies as the most useful form of intersection. The traffic calculations were made for different dates in the future, so that the different stages in the development of traffic in the Hanover area were taken into account with the passage of time (Fig. 4). It showed that the capacity of the intersection was sufficient for the four planning stages. As a result of the traffic studies the crossroad intersection solution was decided upon, and will be carried out as soon as financial resources permit.

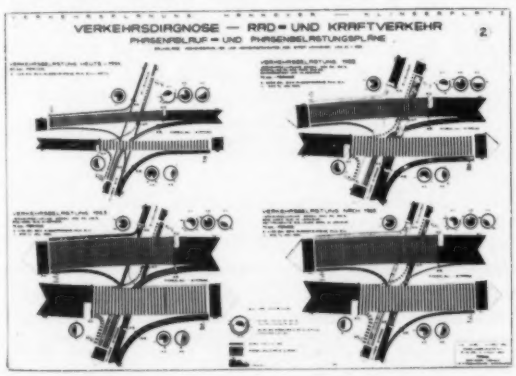


Fig. 4. Hanover, Klingerplatz: Traffic Diagnosis—showing loadings of the intersection in the years 1954, 1958, 1963, and later.

Roundabouts

Traffic roundabout installations are sometimes utilized when more than four roads meet at one point and when there is a high percentage of turning traffic. This was the view of the planner when roads were not loaded to capacity and when overloading could not be foreseen. These were very general planning principles that now belong to history, but with the increase in traffic the role of intersections in the traffic network has become better known. While one should bear in mind the three fundamentals of safety, capacity, and economy in the design of intersections, it is possible to determine by accurate calculation of the traffic which form of intersection to choose. It is therefore wrong to allow an arbitrary judgment to be made between roundabout and crossroad. It is much more necessary to follow through with the different forms of intersection design in each individual traffic study.

In the first stage of design the comparative shape of the present intersection dictates a certain choice. It would be wrong to deduce from general conclusions as to the merits of roundabouts as opposed to crossroads. Apart from this the range of intersection possibilities are restricted by local considerations which play a part in the choice of certain intersection shapes for practical traffic flow, as well as the traffic limitations imposed by local amenities and surroundings. In roundabout installation it is important to consider whether the traffic from neighbouring intersections is conveyed in a continuous flow or in wave-batches—for example from signal installations.

In the design of traffic roundabout installations, it must also be ensured that the geometric form is correct for traffic requirements. Only very seldom does the inflow and outflow of traffic streams correspond equally in each entry and exit to the roundabout. This means that the shape of the middle island is generally an unnatural one for the traffic flow. The design process takes much time to form and must be worked on until the development of the roundabout roadway has fitted the decisive controlling factors of the traffic flow.

Accordingly we can also take note of the recommendations of Radicke[5], for roundabouts with preliminary sorting into individual traffic streams on

the entry roads—thereby theoretically the capacity of the intersection is understandably increased in numbers of lanes, but is seldom realized. In most cases it can only occur when the whole of a traffic network is reconstructed to provide the necessary width to the entry roads, then the required length for the preliminary sorting lanes can be provided with more weaving section. Added to this comes the difficulty of orientating the traffic participator (driver or cyclist, etc.) who must be pre-informed of the intersection for the correct choice of movement for his direction to be made, and that he has no possibility of taking it all in at a glance, and often he does not know the locality.

Neu-Ulm: Allgäuer Ring

By comparative study of the principles of traffic roundabouts and that of crossroads, the points of view of capacity, safety, and economics play an important part. In the calculation of capacity, adopted standards that originate from the same fundamentals should be used. The American Highway Capacity Manual is based on practical capacity for weaving areas and crossroad approaches. There is also the fundamental comparative standard used by Grabe for weaving sections in roundabouts. When the traffic weaving section is loaded under these conditions it is normally calculated at 1,500 with a maximum of 1,800-2,400 passenger car units per hour. And another basis of departure is the result of the trial experiments of the Road Research Laboratory in London[4], in which it was possible to bring 800 test driven passenger car units per hour through each 3 metre (10 ft.) width of weaving section, but not through a full roundabout. Here lies the basis for practical capacity. This comes not only out of the relatively high accident records but also from the reduced approach speed of travel in the entrance roads. It must always be strictly differentiated between the practical capacity analogy and the design capacity, depending on an overloading of the traffic installation based upon possible capacity.

As soon as road safety begins to play an important part in favour of the roundabout solution it has the advantage, when it is an intersection on the city outskirts where inflowing streets with fast traffic approaching from the country highway would be arrested, of influencing the driver to change gear to adjust his speed to city traffic. Then in this instance the roundabout works almost automatically as a brake—and seen from the town planning point of view has a spacial function.

When economy expresses itself as an important item in the construction costs so do traffic costs. On the one hand, with country highways the cost of land generally makes little difference but, with city streets the widening of the traffic circulation space within the intersection area to construct a roundabout is often restricted by the cost, as opposed to the widening of the intersection approaches to make an effective crossroad. The cost in traffic travelling time through a roundabout must be compared with the possible waiting time at a signalized intersection. When, from the standpoint of traffic, the necessity to adopt a signal installation can only be deduced from comparative investigation.

The traffic intersection Memminger Strasse—Ring Strasse (Allgäuer Ring) in Neu-Ulm (24,000 population) is an example of a comparative study of roundabout versus crossroad, which raised the question of whether a signal installation was necessary, and this had a decisive influence on the choice of intersection form. Here there is an oblique angled crossing, with a petrol and diesel filling station, which has highly trafficked routes to the west and south with short access routes to each of them, and a connection to a neighbouring residential street. In 1955, the intersection was carrying about 10,000 vehicles and 5,000 bicycles in a 14-hour day. From both the road safety and the capacity viewpoints it was ripe for reconstruction, but also because there was no other alternative for the important city approach, the Bundestrasse 19, from Allgäu.

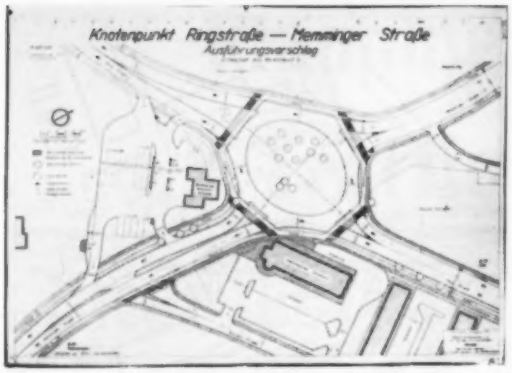


Fig. 5. Neu-Ulm, Allgäuer Ring: General development plan as adopted.

In the traffic studies it was shown that, by making use of a crossroad intersection, it was immediately necessary to instal signals because of the heavy turning traffic from the east to the south along Bundestrasse 19. This particular traffic loading also showed that in a roundabout it was possible to accommodate two and a half times the existing traffic flow. The roundabout in addition exercised the desired slowing down influence on the inflowing traffic and, from the town planning point of view, it also provided a valuable entrance to the town (Fig. 1). Worthy of extra note is that with the help of the town council it was possible to retain the service station in its former location in the existing intersection, and this was best achieved with a roundabout. The service station had to turn its frontage through 180°, but is now even more advantageously incorporated in the redesigned intersection so that it is visible and accessible from all points of approach. The intersection was built during 1957/58 and has functioned faultlessly without any serious accident.

REFERENCES

[1]American Association of State Highway Officials, 'A Policy on Geometric Design of Rural Highways', Washington, D.C. 1957.

[2]American Association of State Highway Officials, 'A Policy on Arterial Highways in Urban Areas', Washington, D.C., 1957.

[3]Highway Research Board: 'Highway Capacity Manual—Practical Application of Research'. Bureau of Public Roads, Washington, D.C., 1950.

[4]M.-E. Feuchtinger: 'Die Berechnung signalgesteuerter Knotenpunkte des Strassenverkehrs'. Forschungsarbeiten aus dem Strassenwesen, Heft 12. Kirschbaum Verlag Bielefeld, 1954.

[5]E. Radicke: 'Klassifizierte Stadtstrassen und ihre Knotenpinkte'. Deutsche Bauakademie. Schriftenreihe des Forschungsinstitutes für Stadtebau. VEB Verlag Technik Berlin (-Ost), 1955.

Neu-Ulm: Allgäuer Ring:

[6]J. G. Wardrop: 'The Traffic Capacity of Weaving Sections of Roundabouts'. Operational Research International Conference papers, London, 1957.

American Report

Experimental Case Studies of TRAFFIC ACCIDENTS

From April 1958 to February 1960 a team of investigators under the direction of J. Stannard Baker, Director of the Traffic Institute at Northwestern University, U.S.A., explored the possibility of discovering a new approach to the problem of road accidents, with a view to evaluating the causes and ultimately improving accident prevention measures. The subject of this paper is a general discussion of the procedures followed and the problems encountered. A second article discussing the exact methods used by the investigators, will be published in Traffic Engineering & Control *November issue.*

OBVIOUS measures to prevent traffic accidents are being widely taken and are, to an extent, effective. However, further reductions in the number of highway accidents first require the discovery and understanding of new and less obvious measures. Unless more is known about the fundamental causes of accidents, and these appreciated, prevention will become increasingly complicated, expensive and restrictive on the use of roads. Scientists who have studied the subject carefully, have concluded that there are too few facts available about the causes of accidents, especially the human elements, to enable them to tackle the problem effectively. Until recently, and sometimes even now, the manifestations have been attended to with neither the knowledge nor understanding to make a true diagnosis.

At the heart of the problem of obtaining accurate information on accidents is the difficulty of studying them. Accidents, unlike most research subjects, occur unexpectedly. To make things worse, a crash usually starts, happens and is finished in, at most, two or three seconds of confused action. This action can neither be provoked, controlled nor studied: only the results can be seen by a scientist or technician-investigator. Eye-witness accounts are often quite unreliable and the statements of the drivers and passengers involved are very seldom unbiased. Few drivers can accurately and factually report what happened; usually the blame is thrown on to the other drivers involved, or, at best, the instinct of self-protection from the legal results draws a cloudy veil over the truth. Within even a short time, a person trying to stick accurately to the facts will distort the truth, perhaps very slightly, but always in his own favour.

Previous Approaches

One method used in the attempt to gain insight into the causes of accidents is the study of the conventional police reports. However, these reports are written on standardized forms with supplementary sheets sometimes added. As often as not, the report contains no more than a primitive sketch, which is rarely to scale, and about 100 words of description and police comment. The phraseology used may make the statement ambiguous, the points selected for emphasis vary entirely according to the inclination or even whim of the reporting officer and, above all, the attitude of the police heavily influences the opinions and conclusions which can be drawn. Two major efforts have been made to utilize the spontaneous comments of reporting police officers, but both these were constricted by the stereotyping of the accident factors used and by the limitations of the officers in making deductions from the information in their possession.

A second approach to the problem, one that has been used from time to time, is through supplying the

investigating police with supplementary forms on which to report factual information. This is usually done for a limited time and over a prescribed area. Some of these attempts have met with a certain amount of success. The most extensive are the researches of Cornell University into automotive crash injuries: the University has been gathering information for a number of years on the injury-producing aspects of motor vehicle accidents.

The third method is to supplement police reports with special investigators who have been technically trained. This method is most commonly used by lawyers, who employ engineers and doctors to study the causes of an accident which might result in the legal liability of their clients. Rarely indeed has this approach been made by research workers, and, because of the liability involved, the investigators are not often inclined to attack the problem with a completely unbiased mind.

The Experimental Case Studies project was not conceived as using any of these precise methods, but rather as a clinical study of each accident as it occurred. Later, if sufficient data on a large enough number of accidents had been amassed, the subject could usefully be treated statistically. The main object though was to develop new techniques of evaluating the road where the accident happened, the vehicle or vehicles concerned and, in particular, the people involved and applying this evaluation to accident prevention.

Fig. 1. One of the accidents investigated by the team from Northwestern University.

Interdisciplinary Participation

The experience of the armed forces and industry—where inquiries by teams or boards of experts, each with applicable but specialized knowledge, have been successful—suggested that a similar approach might prove the most fruitful. Thus, the most unusual feature of the Case Studies project was the participation of specialists from totally differing scientific fields. As finally chosen the investigating team consisted of three members representing medicine, engineering and sociology: the medical representative had a special interest and training in psychosomatic medicine, the engineer was a civil engineer and the sociologist had specialized in the study of neighbourhoods and their development. At first it was intended to train these investigators in the methods used by the police, but since these were for enforcement rather than scientific analysis, and contained much dogma of doubtful validity, it was decided to allow the scientist to observe and investigate without guidance. It was felt that this approach was more likely to produce new and valuable findings than if the team had been previously indoctrinated by police methods. The team did not study material collected by the police or others, but they themselves secured whatever information they felt useful or desirable, modifying their methods and data gathered as the work progressed.

From the composition of the team and the method of working, certain problems of operation arose. Having such different training and technical languages, the investigators did not at first merge into a smoothly functioning body. Communication between individuals always tends to develop misunderstandings in exact meaning and this is exaggerated greatly when language is used technically. Certain words to a scientist specialized in one subject may, and very often do, have different meanings in the vocabulary of a specialist in another field. This then was one reason for the progress of the team being slow in the early stages. The second problem to be overcome was the individuality of the members. The academic environment is probably less favourable to interdepartmental research than, say, governmental, industrial or military backgrounds, where far less emphasis is put on personal achievement. In academic institutions, the premium placed on the authorship of publications, and the constrictions set for professional dissertations and lectures or papers, tend to make each member of a group accentuate the value of material which will, theoretically, increase his personal or professional stature. These two problems contributed to the time required to learn the basic necessity of team work. Perhaps the time would have been shortened by special training for the project, but if that had been done, the principle of a fresh approach would have been sacrificed.

The Collection of Data

At the beginning of the project, the Evanston Police Department undertook to inform the investigating unit of all accidents, but after a few months of suspicion a spot check of the police files revealed that less than two-thirds of the accidents occurring had been reported to the scientific team. Because of this a monitor radio set was obtained, tunable to police wavelengths, and this enabled investigators to reach the scene of the crash with a minimum of time wasted. The police further co-operated by agreeing to waive prosecutions, except those involving drunkenness or vehicle defects which would become more dangerous if permitted to continue. Almost all accidents involve some violation of a traffic law, however slight, and this co-operation was calculated to make the drivers' participation in the survey easier and their assistance more likely to be forthcoming.

Through Traffic Prohibition Burton upon Trent

by **J. P. Wain**, A.M.I.C.E., M.I.Mun.E., A.M.T.P.I., *and* **D. W. G. Fretwell**, A.M.I.Mun.E.

HIGH Street and Lichfield Street are situated in the town centre of Burton upon Trent and form its principal business and shopping centre. For many years congestion in High Street has been steadily increasing, largely due to through traffic being superimposed on a heavy volume of local traffic, which includes local bus services. High Street is narrow for most of its length, the carriageway being less than 27 ft. wide, with a minimum of 22 ft. 3 in.—inadequate for a large volume of traffic without congestion, delay and danger to all. The congestion from heavy industrial vehicles, 67 per cent of the total traffic, was out of all proportion to their number and was made worse by vehicles loading or unloading.

For some years an alternative route for A38 was directional sign-posted via Park Street, Orchard Street, Union Street and Guild Street and although some through traffic used this route a substantial amount continued to use High Street and Lichfield Street. The alternative route passes to the west of the principal shopping and business centre and is much more suitable for through traffic, being generally free of the type of frontage development which generates much traffic or causes waiting.

The Council felt that the easiest way to reduce congestion to road users in High Street (pending completion of A38, Burton By-Pass) was to prohibit the passage of through traffic in High Street and Lichfield Street, between the junction of Lichfield Street and Park Street and the junction of High Street with Horninglow Street, Wetmore Road, and Bridge Street.

After considerable discussion, an Order under Section 33 of the Road Traffic Act, 1956, was made by the Council and confirmed by the Ministry of Transport. The proposal, supported by the Chief Constable of Staffordshire, prohibits the passage of through traffic on week-days between 8.0 a.m. and 7.0 p.m., motor cycles and public service vehicles excluded. Through traffic is taken as that passing along the full length of High Street and Lichfield Street without reason to call at premises adjoining these roads or to turn off along the relatively few intermediate side roads. The procedure followed that outlined in Ministry of Transport Memorandum No. 747, consultations being undertaken with representative bodies. A number of objections were received, but the Minister confirmed the Order without a local inquiry, having previously received an undertaking from the Corporation to review the scheme after two years.

In order to facilitate the movement of traffic on the alternative route, certain No Waiting Orders were made, and directional sign-posting throughout the town centre was considerably strengthened and modified, traffic signal installations were retimed as necessary, and lane lining at junctions was improved.

The Order has now been in operation for four months and has been very successful in relieving congestion in High Street and Lichfield Street. The alternative route has worked well and in general there have been considerably less teething troubles than anticipated. During the first week the Police exercised almost constant supervision, but once the majority of general traffic users were accustomed to the scheme no abnormal Police supervision was required.

Before and after studies of traffic volumes (Table 1) and journey times have been undertaken.

The totals include all vehicles, including motor cycles and buses.

Journey Time Studies

For the purpose of journey time studies, a Bedford Dormobile was driven some 20 times in both directions over the two routes from the junction of Park Street and Lichfield Street to the junction of the routes on A38, by the Borough Boundary at Derby Road.

Comparative histographs of the journey times are given in Figs. 1 and 2.

A new by-pass for A38 traffic, planned for some years, will be a new road constructed to motorway standards, and the centre line and side road orders for it have recently been published by the Ministry of Transport. The No Through Traffic Order can best be regarded as an interim measure to cope with a steadily increasing traffic problem, but it must be emphasized that it is no substitute for the provision of the necessary roads.

Illustrations of the affected streets are on pages 354 and 355.

TABLE I
Traffic Volumes

	High Street			*Guild Street (Alternative)*		
	Cars	*Lorries*	*Total*	*Cars*	*Lorries*	*Total*
Before	3,906	3,199	8,196	2,636	2,768	5,757
After	3,422	1,726	6,264	3,098	4,080	7,700
	484	1,473	1,932	462	1,312	1,943
Variation %	—12%	—46%	—30%	+17½%	+47½%	+34%
	Lichfield Street			*Orchard Street (Alternative)*		
Before	2,136	2,207	4,801	1,416	2,275	3,843
After	1,488	826	2,964	1,954	3,694	5,889
	648	1,381	2,107	538	1,419	2,046
Variation %	—30%	—63%	—44%	+38%	+62%	+52%

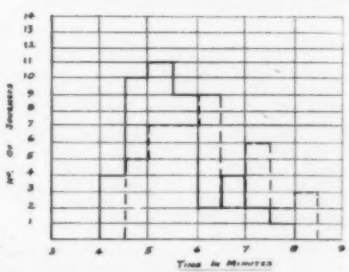


Fig. 1. Comparative Histograph of Journey times via High Street.

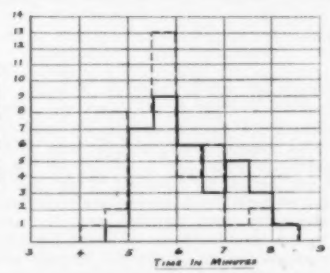


Fig. 2. Comparative Histograph of Journey times via alternative route.

Fig. 1. A view of the Highway as it follows the valley of the Thompson River.

THE TRANS-CANADA HIGHWAY

ALTHOUGH the need for a continuous road to link the Atlantic Coast of Canada to the Pacific Coast was probably recognized as soon as the construction of the Canadian Pacific Railway was completed, the first organized effort towards fulfilling this requirement was the formation of the Canada Highway Association in 1910. Following the lead given by this organization, several automobile and good roads associations advocated, with widely varying degrees of enthusiasm, the building of a trans-Canadian road. However, although no objections were made to the idea, no concrete proposals were put forward either.

After the First World War, there was an unprecedented expansion in the registration of motor vehicles and on practical grounds the demands for good roads became more imperative. Even then, the immediate demand was not so much for long-distance facilities. It was the construction and improvement of local and inter-regional roads within the provinces which received priority. It became evident at this time that some degree of provincial, as opposed to local, responsibility would have to be taken to build up a system of roads from farms to markets. This led to grants being made by provincial governments to municipalities, and, in turn, to the establishment of trunk highway systems under provincial jurisdiction. In recognition of the value of these roads to Canada as a whole, financial grants were made towards the improvement of the systems from federal sources. However, it was not until 1948 that the Federal Government felt the need to co-ordinate and assist in the construction of Canadian roads. Before then, improvement of existing roads and the construction of new ones were left entirely in the hands of the provincial governments controlling the areas through which they ran.

In 1948 a conference was held of provincial authorities and the Federal Government. This conference discussed the possibility of co-operation between the participants in the construction of a trans-Canadian road of certain agreed standards. The success of this meeting led to the passing of the Trans-Canada Highway Act of 1949. A second conference was held almost immediately afterwards to discuss and decide the necessary standards, a time schedule and the operating procedure. Even at this stage there was no dictation by the Federal Government: agreement was reached between the provinces.

Design and Route

The general conception of the Trans-Canada Highway was of a two-lane carriageway of certain geometric standards and built to design criteria as given in Table I below.

It will be seen from this table that the design was not elaborate. It is, on the other hand, expected to prove quite adequate for the anticipated volumes and character of the traffic and it should allow vehicles to move within the legally imposed limits of speed, with as much safety as design and planning can provide.

TABLE I

Standards for Trans-Canada Highway

Right-of-Way		Minimum	100′ width
Curvature		Desirable 3° ...	Maximum 6°
Gradient		—	Maximum 6%
Sight Distance	... Vertical	Min. 600′	—
	... Horizontal	Min. 600′	
Pavement	... Width	Min. 22′	Maximum 24′
	... Depth	Min. 3″	—
	... Loading ...	Repeating 18,000 lb. axle	
Shoulders	... Width	Min. 5′	Maximum 10′
Bridges	... Loading	H20-S16	
	... Overhead Clearance	Min. 14′-6″	
	... Width ...	For length 30′ or less	Width of pavement plus shoulders
	...	For length 30′-100′	Minimum 27′
	...	For length over 100′	Minimum 24′

Fig. 2. Construction crews flatten out a mountainside to carry the Highway through the Glacier National Park in the Rocky Mountains.

Under the agreements reached in December 1949, at the second conference, the route was to be designated by the provinces, but was to be subject to approval by the Federal Government at all stages. As far as was practical, the road was to follow the shortest line from east to west, but to remain consistent with the needs of the individual provinces and in the interests of the Dominion of Canada. The final route, which was a revision of previously approved plans, was eventually chosen to include the following total mileages in each province. (Table II).

TABLE II

Provincial Allocation of the Trans-Canada Highway in miles.

New Brunswick	390
Quebec	398
Ontario	1,453
Manitoba	309
Saskatchewan	406
Alberta	282
British Columbia	568
Newfoundland	540
Prince Edward Island	71
Nova Scotia	318
National Parks	140
Estimated Total Mileage ...	4,875

Beginning at the far eastern end, the Newfoundland section of the Highway traverses the hard rock terrain of the Canadian Shield. Although road construction on this type of ground is both difficult and very expensive, the natural impediments did not lessen the keen desire of the Newfoundlanders for this road, which was badly needed for the development of the province. Almost due south of the eastern extreme, in Nova Scotia, the problem was not of building a road from scratch but rather of improving the existing facilities to meet requirements of the agreement. Actual construction work began on this stretch in 1954, with the replacement of narrow, sub-standard bridges. It should be mentioned that the Canso Causeway, which in fact carries the Trans-Canada Highway from Cape Breton to mainland Nova Scotia, was a separate project and, although also a joint federal-provincial undertaking, not part of the main enterprise. Canso is the deepest man-made causeway in the world.

In Ontario, a paved road already existed from the Quebec border, through Ottawa to Sault Ste. Marie on the Great Lakes. However, much of this section had to be relocated and rebuilt to new specifications, which in part are to full 'thruway' standards, under the National Capital Plan for development round Ottawa. West of the capital the terrain, similar to that of Newfoundland, is the hard rock of the Precambrian Shield where not only the actual construction proved a tremendous problem, but the supply of labour and equipment became a question of logistics. From the Ontario border, the road crosses the Prairie Provinces of Manitoba, Saskatchewan and Alberta. Throughout these provinces the Trans-Canada Highway is either a completely new undertaking begun from scratch, or the old trunk routes have been entirely reconstructed to the new design. Work was held up in the Assiniboine Valley, west of Winnipeg, by flooding. Every opportunity offered by difficult ground had to be taken, particularly in the building of a bridge to carry the road over the Assiniboine River. This was done in a remarkable way. The bridge structure and approaches were built on dry ground well away from the river itself, and when these had been completed the river was diverted underneath in a controlled channel cutting across the ox-bows of the meandering course.

The road through Saskatchewan was declared open in 1957 and is drawing the ever increasing truck traffic that was previously diverted through the United States. In Alberta a refinement has been added to the agreed standard—the provision of bitumen surfaced shoulders to the main pavement. This has also been adopted generally in the National Parks.

To cross the Rocky Mountains, the road runs along the side of the Kicking Horse River and here comes in conflict with the railway. As though the problem of cutting a path out of the side of the mountains was not difficult enough, it had to be done in such a way that there was no danger to the railway track running below and the telegraph, telephone, and broadcasting lines which also ran through the narrow Rogers Pass. With the Rockies passed the way to Vancouver was comparatively simple.

Snow Protection

The route chosen through the Glacier National Park, in the Rockies, is a daring one, being a short cut through the heart of the mountains. The Park is an area where avalanches are common and the road had to be protected. This was done in several ways.

The first line of defence against the snow is the raising of earth mounds in the known path of snow-slides. The mounds, which are conical in shape and 12 to 25 ft. high, break the avalanche at the base and destroy its force. For the

Fig. 3. In the Fraser Canyon, the Trans-Canada Highway and the Fraser River run side by side.

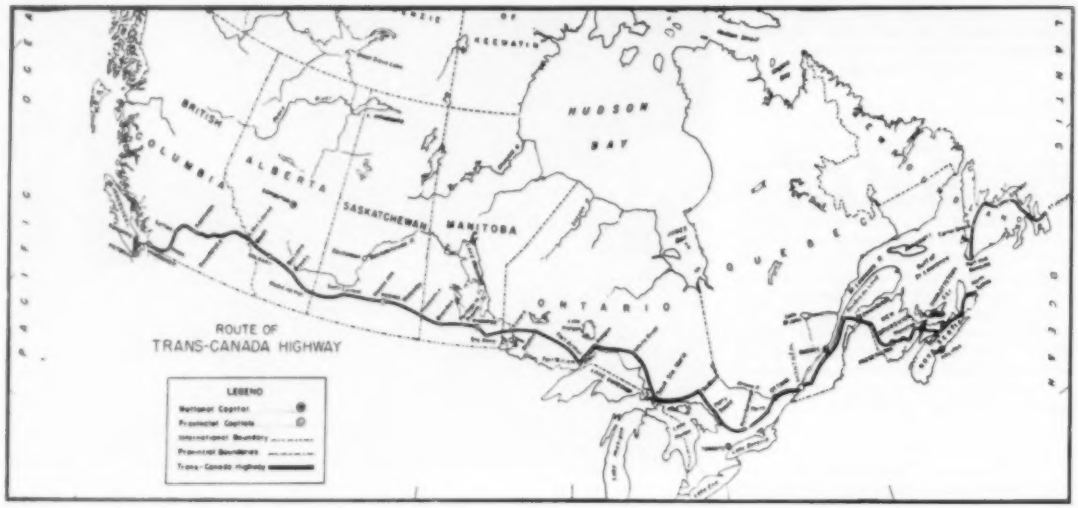


Fig. 4. The route of the Trans-Canada Highway; 4,875 miles from Newfoundland to Vancouver.

times when this barrier is unsuccessful in stopping the slide, earthworks, sometimes 1,000 feet long, 150 ft. wide and 10 ft. high have been built to catch and hold the falling snow, slowed by the mounds. As a final resort, and in places where research shows that the danger of avalanches is greatest, sheds of steel plate on concrete foundations have been constructed over the carriageways. These are not to stop the avalanche but to protect the road when the snow is uncontrollable, and in an area where the average winter fall is 360 inches, control is exceptionally difficult. One minor setback encountered in avalanche control was the limitations imposed on the use of preplanted explosives to break up the snow formations before they became dangerous. The grizzly bears regularly ate the charges with relish and apparently no ill-effects.

Finance

Under the Trans-Canada Highway Act, the Federal Government agreed to finance the road to the extent of 50 per cent of the total cost and where existing roads were accepted and approved the provincial governments could claim up to 50 per cent of their original expenditure. The total federal contribution, however, was limited to $150 million. A subsequent amendment to this agreement was made in 1956 increasing the maximum allowed from federal sources to $250 million, but at the same time the Canadian Government provided for an additional contribution of 40 per cent of the cost of one-tenth of the mileage in each province. A second amendment to the Act, made in 1959, increased the limit to $350 million and a third, passed a few months later, to $400 million. In addition to these contributions, the Federal Government agreed to take full financial responsibility for construction in the Glacier, Banff, and Yoho National Parks. The total cost to federal funds, originally estimated at $150 million eventually became more than $364.7 million by January 14, 1961. Expenditure is broken down in Table III.

TABLE III

Trans-Canada Highway Contractual Commitments at January, 1961

Province	Total value approved work	Canada's share Incl. additional 40%	Canada's Share Paid to date
Newfoundland	$44,397,577.36	$28,550,904.45	$25,990,033.76
P.E.I.	9,135,542.28	5,898,166.25	4,979,962.09
Nova Scotia	23,668,325.21	16,779,001.27	11,388,822.19
New Brunswick	53,330,779.76	35,091,184.63	32,613,130.56
Quebec	1,100,000.00	550,000.00	—
Ontario	203,564,326.90	117,051,338.42	81,948,360.95
Manitoba	33,534,583.15	19,241,680.38	16,909,457.81
Saskatchewan	27,852,050.32	15,911,170.17	15,285,982.75
Alberta	37,047,407.57	22,162,905.16	20,827,231.13
British Columbia	179,854,542.06	103,526,130.50	77,166,081.77
TOTAL	$613,485,134.61	$364,762,481.23	$287,109,063.01

Conclusion

By the end of 1961 the final gaps in the construction of the Trans-Canada Highway will be filled and the total length of 4,875 miles will be opened to public traffic. The road will have taken 11 years to complete: in part it will consist of existing roads improved and in part of completely new carriageways built to an agreed design standard. This standard is not over-complicated, but is planned to fulfil the needs of anticipated growths of long distance traffic for a high degree of safety and a good surface for the whole of what will be the longest continuous national highway in the world.

NEXT MONTH

Reports from the:

WORLD TRAFFIC ENGINEERING CONFERENCE, WASHINGTON

ASSOCIATION OF PUBLIC LIGHTING ENGINEERS CONFERENCE

THE CONVENTION ON PLANNING FOR TRAFFIC OF THE INSTITUTION OF MUNICIPAL ENGINEERS

ADVANCE WARNING of HALTED VEHICLES

by Cornelis Kuysten,

Civil Engineer, Head of the Traffic Engineering Department of the Royal Dutch Touring Club (ANWB)

SPEED in itself is not an important element of danger. It is only a difference in speed between two vehicles following the same track that brings the danger of a collision. Three examples follow:

(1) Accident statistics in the Netherlands have proved that a road with mixed traffic of motor vehicles and bicycles is two and a half times as dangerous as when the bicycles are on a separate cyclepath beside the carriageways. It is well known that one or more cycles on a carriageway are a nuisance and a danger to traffic safety, because, to overtake, motor traffic must pull out suddenly.

(2) It has been shown that motorways are five to seven times safer than roads with mixed traffic, not only because they are grade separated and allow no right turns (for left-hand traffic), but also because no slow driving traffic is permitted on these roads.

(3) At first, motorways were built without hard shoulders and broken down vehicles had to halt on the carriageway. This resulted in accidents both by day and night. Now international practice is to give motorways a special parking lane, that is a hard shoulder on to which vehicles can be driven or parked.

Fig. 1. The scene of an accident is clearly indicated by a red reflective triangle.

It is evident that a stationary car on the carriageway of a country road is a danger even by day. This last fact is not always recognized. The police and the courts are apt to claim that it was daylight and that there was no reason why the stationary vehicle could not be seen; that it was not forbidden to park or halt, and so the defence that the stationary vehicle was a contributory cause may consequently be found to be unacceptable. It is further claimed that speed was excessive and that it would be a strange world if one were not allowed to stop. The result is that the driver who runs into a stationary car is found guilty of having been driving without due care and attention. Only when the police drive cars do they understand better, because they know that vehicles even if driven at low speeds, which differ greatly from what is the *normal range of speeds*, are a danger. So halted vehicles and low speed vehicles give a still higher degree of danger.

In the Netherlands, during Easter 1961, it was found that, at a stretch of motorway after a roundabout with traffic lights, 200 cars were damaged in several chain accidents in one night because some slow driving Sunday drivers had caused sudden stops of other vehicles. So speed difference means danger, stationary vehicles on the carriageways mean greater danger and at night even more danger.

It is strange again that once an accident has happened with a car halted at night on the carriageway, the law often takes the view that the halted car has not been a cause of the accident. They may argue that the driver of the other car had his headlights on, that he obviously had not adopted his speed to circumstances; that he always had to think about the possibility of cars without rear lights on the carriageway, etc. If, however, the stationary car had its rear lights on, then the driver of the oncoming car may be found guilty without lengthy discussions.

In every country there is great

misunderstanding about the danger that is caused by the man that halts a car on the carriageway at night. The danger is not avoided when the rear lights are switched on, for the driver of a moving vehicle, once he sees rear lights before him, will think that it is a car driving at a certain speed, which is most probably the case. When he discovers that the vehicle is stationary, it is frequently too late to avoid a collision. Many solutions have been tried, including warning installations on the cars, such as intermittent lights, turning lights, etc. The obligation to have two rear lights plus two reflectors became Dutch Traffic Law in 1955.

The application of the principle of advance warnings was found a satisfactory solution to the problem. On February 7, 1951, the Royal Dutch Touring Club, with the help of traffic police, gave a demonstration of a reflective triangle to the Dutch Minister of Transport and a number of experts and authorities. The site for the demonstration was a dangerous one: a busy four-lane road near The Hague. On a part of this road without public lighting, a car was halted on the carriageway and two triangle signs with red reflective borders were placed 'upstream'. The demonstration was convincing: the traffic was guided to the middle of the road as with a magnet: it did not stop nor was it thrown into disorder. For the same demonstration, another symbol was prepared, consisting of a horizontal line with round reflectors. This one was tried for only a short time because, when the first vehicle stopped because of it, the police forbade further trials with this sign.

The Royal Dutch Touring Club after these demonstrations, proposed that the Minister should bring in a law requiring that cars, stopping on the carriageway at night should be provided with a reflective triangle sign, placed 30 m. behind it. The Minister, nearly two and a half years later, accepted this proposal, with a few changes for reasons of compromise: he did not accept the triangle but brought into the law the obligation to place a device that gives a red light or is red reflective.

Red lights and red reflectors, in fact, are not sufficient protection for halted vehicles, as statistics show, for they do not specify that the vehicle is halted. This lack of a complete and clear indication often leads other drivers to make mistakes about the distance and speed differences. Moreover, when a vehicle is hidden behind a hill or round a bend, the red lights are not visible to oncoming motorists and there is nothing to indicate the presence of the obstacle formed by the vehicle hidden by this natural mask due to the road and ground configuration. This is where the triangular advance warning sign is of tremendous help.

There are still some gaps in the law: in the Netherlands there is no obligation to carry a device in the car at all times; the dimensions should be prescribed, and the law only requires the device to be used when the rear lights are not working. The law should be changed and a triangle prescribed.

In 1954, the following figures from the Bureau of Statistics for the years 1951 and 1952 were published by the Touring Club: during these two years 456 trucks, parked on the carriageway during the hours of darkness, were hit. In 122 cases the rear lights were not on, and in 148 cases they were. In 186 cases this was not registered on the accident form. Of these 456 cases in which a stationary truck was hit: 208 of the vehicles were hit by a car or truck, in 47 cases by a motorcycle, in 21 cases by a moped and in 73 cases by a bicycle. Of these accidents: 250 happened where there was street lighting, so one could conclude that more than half happened within built-up areas.

Accidents involving stationary trucks at night are more likely to be serious, even fatal, than in the case of stationary cars. Figures for the year 1952 (the only ones available) show that of 206 accidents involving trucks halted during hours of darkness, eight resulted in fatalities and 61 in serious injuries. In the same year, with cars halted after dark on the carriageway: 207 accidents had no fatal results and 20 serious injuries. The investigation showed that of the eight cases with fatal results when a truck was halted on the carriageway, in six the rear lights of the truck were on. It seems desirable, therefore, to make it obligatory to use the reflective triangle in all cases and not only when the rear lights are on. On well lit streets of course, there is no necessity to use an advance warning.

International discussions on the problem created by vehicles stopping on the carriageway took place at the Geneva Working Party on the Prevention of Road Traffic Accidents as early as 1952, and resulted in the recommendation of September 1952 that Governments make it compulsory for heavy vehicles to use a reflective device when halted on the carriageway during the hours of darkness. Further discussions in Geneva followed; several countries accepted the triangle and recently preparations have started to amend the Convention to prescribe that when a vehicle is halted on an unlighted carriageway at night, a reflective triangle of 40 cm. with a 5 cm. wide red border be placed as an advance warning.

Regarding the regulations at present in force in some countries, the following details are available:

In Germany, since 1956, every motor vehicle halted on the road at night must be made known to oncoming vehicles by means of a red lamp, flare or reflective device. Trucks of 2.5 tons or more must carry two devices with them.

In France, since 1954, a reflective triangle is required to be placed at 30 m. behind trucks of 3.5 tons or more, at dark and at times of bad visibility by day.

In Belgium, since 1958, a reflective triangle of 40 cm. is required to be placed at 30 m. behind vehicles exceeding 3.5 tons. On motorways the distance must be 100 m. This regulation is in force both in daylight and at night.

In Italy in 1959 it became obligatory for all stationary vehicles to be pre-signalized in all cases of bad visibility and at night with a reflective triangle of 45 cm. at a distance of 50 m.

In Spain, in 1960, it was required that vehicles of more than 3.5 tons weight use a triangle day and night.

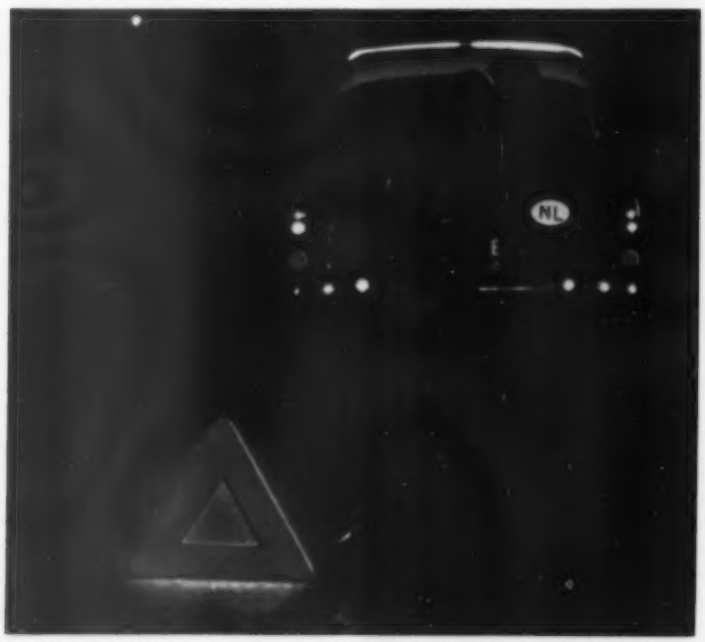


Fig. 2. A reflective triangle warns of a breakdown where the stopped vehicle is only partly on the verge.

Conclusion

In countries with modern traffic laws rather extensive prescriptions are made to meet the dangers of vehicles halted on the carriageway, both by day and night. The sign that is prescribed is the triangle of rather large dimensions, 40–45 cm. Reflective material for the red border is required and it is obvious that there is no need for the use of more complicated devices, as the triangle has proved to be simple and effective.

PUBLIC LIGHTING IN PAISLEY

Paisley's modern street lighting.

Extracts from a paper given by John Wilson, Public Lighting Engineer of Paisley, to the Paisley Rotary Club.

STREET lighting is a subject which has become more important during the last 15 years due mainly to the great increase in road traffic and also to assist with public safety. The Burgh of Paisley has always been conscious of this, and its large electrical installation has experienced many changes over the years, mainly due to the great amount of experimental work carried out in order to ascertain the correct type of lighting and to keep abreast with modern progress. Since the cost of street lighting can be expensive it is essential that great care should be taken when envisaging lighting schemes that the type of installation proposed should not become outdated prematurely in a fast changing era.

In 1897 the first electric lamps were erected in the streets of Paisley and it is interesting to note that the 90 which were erected within the main streets were supplied direct by a 2,000 volts A.C. supply, a system which would not be allowed under the I.E.E. regulations today. These lamps were of the carbon arc type and were sited very far apart, often in the region of 100 yards. The side streets were lit by gas of the two and three mantle type and were spaced at approximately 60 yards.

In 1906 this system was replaced by 90 carbon arc lamps but were now supplied by direct current at a potential of 575 volts taken from the bus-bars of the plant supplying the Paisley & District Tramway Co. The side streets were still lit by gas.

In 1919 the system was again replaced by 90 500 watt carbon filament vacuum lamps which gave a yellow type of illumination but was steady although less efficient. This change was made due to the high cost of maintenance of the carbon arc lanterns and also in order to follow the modern trend.

In 1925 commencement was made on the electrification of all the street lighting in the town and twin armoured cables were laid in all the side streets for this purpose. In the main streets overhead cables were erected on the tramway columns. The type of illumination adopted was the white opalescent globe with tungsten lamps ranging from 100 to 500 watts in size. The control system was by a series of 30 amp. contactors arranged in Cascade and the circuits emanated from Blackhall Power Station in numerous directions with the entire system switched on and off by the control room attendant. This system was the first centrally controlled installation in Britain, furthermore Paisley was then the only town in Britain with no gas street lighting, and the total number of electrically lit lamps in the town at that time was 1,200.

The opalescent globe type of street lighting had a high aesthetic value but the efficiency was comparatively low and was in the region of 50 per cent. The height of the low lamp was 12 ft. and the high lamp 19 ft.

In 1927 it was again decided to improve the public lighting in the town but on this occasion it was the stair lighting that was being improved and between 1927 and 1929 all the stair and close lighting was converted from gas to electricity. The stair lighting installation was coupled to the street lighting system and was centrally controlled. The total number of stair lamps at that time was 2,500. Again Paisley was the first town in Britain where no gas lighting existed in the stairs and closes.

In Gallowhill Road in 1935 mercury lighting was installed for the first time in Scotland and, in 1937 at Fergusliе, one mile of sodium lighting was also installed for the first time in Scotland. The mercury lighting was removed about nine months later after having been christened by the residents of the area as 'death lights' due to the blue colour of the lamp.

Street lighting in Paisley was so efficiently controlled that the Government decided that Paisley be used as the location to experiment with black-out street lighting during the war, knowing that its street lighting could be extinguished immediately on receipt of an alarm. The lighting experiments were studied by high level technicians and government officials and decisions taken by means of communication between their planes, Blackhall Power Station, and certain aerodromes.

In 1946, after the cessation of hostilities, a further change was made in Paisley's street lighting due to the great increase in road traffic, the use of the opalescent globe was discontinued and refractor control of illumination was adopted. Prisms were incorporated in the outer glass bowls and these prisms directed the light from the lamp to where it was most wanted. This system is used to the present day to a great extent.

In 1946, 5 ft. fluorescent fittings were erected in New Street and were the first in Scotland. Deputations from other Local Authorities visited Paisley to inspect them.

More recently, all the side street lighting has been converted to the mercury vapour type. Most of the main streets have been converted to fluorescent mercury while most of the main roads in the housing developments have been converted to sodium lighting or high pressure mercury vapour. The control of this lighting emanates from a panel located in the Lighting Department's premises and during the last 11 years the street lighting has been switched on and off by selenium cell equipment commonly referred to as the 'electric eye', therefore no labour or other means is used for this purpose. Ten circuits leave the main panel and traverse the town in various directions.

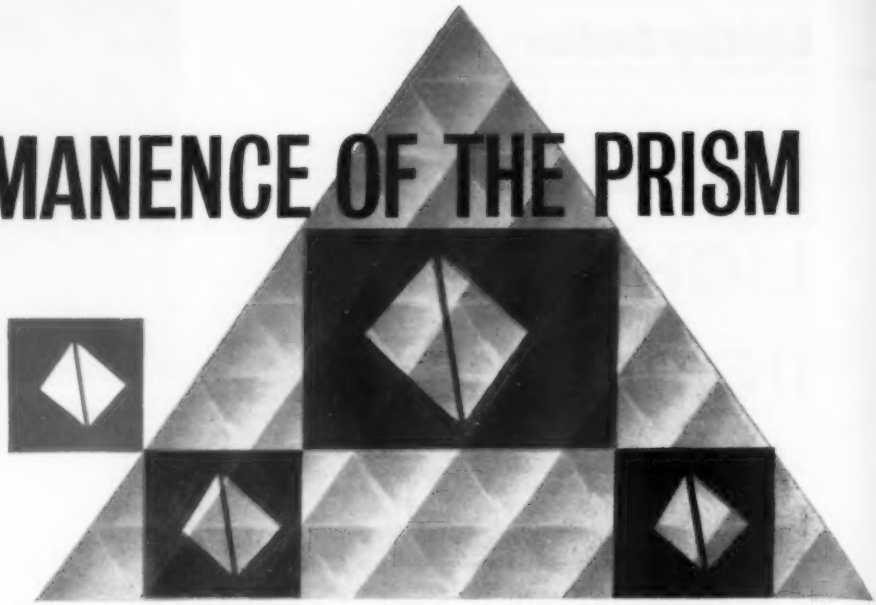
An electrical installation of such magnitude requires much maintenance

(*Concluded on page* 370)

TEC647 *for further information*

THE PERMANENCE OF THE PRISM

SEE STAND 13
AT THE A.P.L.E.
EXHIBITION



Holophane street lighting units not only give unchanging service for an unlimited period of time, but also provide precise, scientific control of light owing to their unique prismatic design. Constructed of transparent crystal glass, Holophane reflectors and refractors permanently withstand heat, damp and atmospheric impurities of all kinds. And, with up to 90% control of lamp output which can be deployed in any manner desirable, these units enable any specific problems of siting or light distribution to be solved without difficulty. From the full range of Holophane units—a few of which are seen below—all needs for both "A" and "B" roads can be met. Please contact Holophane for more details of this unique, scientific approach to street lighting which is backed by over sixty years' uninterrupted research and experience.

HOLOPHANE scientifically controlled street lighting

★ *Oval Bowl Refractor for Group A Mercury Discharge Lighting.*

★ *Single-piece Lumifractor Lantern for lighting narrow Group B roads.*

★ *Muralux Houseside Lantern for Group B street lighting. For wall mounting in congested areas.*

★ *Post-top Refractor Lantern, pedestal-mounted for Group B roads.*

HOLOPHANE LIMITED - ELVERTON STREET - WESTMINSTER - LONDON - S.W.1 - Telephone: VICtoria 8062

STREET LIGHTING over 25 YEARS

H. CARPENTER, M.I.E.E., F.I.E.S., M.A.P.L.E.

Modern street lighting.

DURING the past 25 years various influences have affected street lighting development and practice—the light output (luminous flux) for the average street lighting lamp on traffic routes will soon have trebled, whilst for other roads it has more than doubled. Statistics show that the average light output per ratepayer has increased from about 200 to 600 lumens. The levels of illumination in use for public lighting improved only slowly until the advent of electric gaseous discharge lamps in the early 1930's. With the outbreak of war development ceased, except for specific research, and this was followed by a period of shortage of materials and manufacturing difficulties, so that several years elapsed after the cessation of hostilities before new lighting schemes could be considered. Since 1950, the rate of improvement has quickened appreciably due to advances in lantern design and light source efficiency—progress which we hope will continue.

Improving Equipment

The illuminants used for public lighting have been changing. Gas lighting, which in 1936 was in use for nearly half the main traffic route lighting in Britain, has almost disappeared and is now responsible for less than one-tenth. The modernization of the lighting of side roads and suburban avenues has been slower, but electric lighting, then in use on only about one-fifth of these roads, is now the illuminant on nearly three-quarters. Gaseous discharge lighting (H.P.M.V. and sodium) has gained popularity and tended to replace pre-war tungsten lighting, whilst latterly there is an increasing tendency to use tubular fluorescent lighting, particularly in town centres and other localities where style and quality of lighting is important.

Nowadays, about 48,000 miles (25 per cent) of the roads in Great Britain are lighted, in some form or other, by over 1¼ million street lamps, though about 5 per cent of urban roads are still unlighted. On average this is about one street lamp per 20 inhabitants, although, from town to town, this varies from 1:24 to 1:12.

Post war, there has been a trend to lower the D.I.R. of lanterns used for main road lighting and the medium angle lantern has proved an acceptable compromise. Vision is improved, since there is less glare than from the pre-war high angle lantern and, with proper spacing, it produces a better light pattern on the rougher and darker modern road surfaces. Cut-off, or partial cut-off lighting has become more widely used, especially on the Continent, and wall mounting installations and attractive post-top lanterns have become popular for shopping and business precincts. For suburban side roads, it has been realized that it is more important to light the whole visual scene rather than concentrate on roadway illumination; well illuminated footpaths are essential, with sufficient 'spill light', falling on gardens and house fronts, to produce an overall bright and cheerful atmosphere.

It is surprising how much the street scene has changed even in the past 10 years. The old and inefficient installations are becoming a rarity and, perhaps not rapidly enough, being replaced by modern lighting schemes of conventional style, or the less orthodox designs being pioneered in this country and abroad. Latterly, the aesthetic design of street lighting furniture has appreciably improved due to the active work of such bodies as the Royal Fine Arts Commission, the Council of Industrial Design and the Civic Trust receiving appropriate response and co-operation from manufacturers and industrial designers. The practising engineer should welcome aesthetic guidance if it is reasonable and sensible, and, providing utilitarian requirements are not unduly sacrificed, an acceptable compromise is always possible. In planning, after first deciding on the illuminant to be used, and the appropriate lighting geometry, suitably matched lanterns and columns should be carefully selected for each location to ensure that the resulting effect is completely in character.

Reductions in Cost

Lighting is one of the few commodities which, over the years, and particularly post war, has progressively and substantially reduced in costs. All forms of lighting, whether for home, factory, office, or public lighting, are relatively cheaper—the result of a combination of efforts for which credit is due to the manufacturers of lamps and fittings and to the Electricity Authorities for maintaining low unit prices despite appreciably increased fuel costs.

Sodium lamps, with the recent innovation of the linear lamp, now have an initial efficiency of 100 lumens per watt—an 80 per cent improvement since their introduction; H.P.M.V. lamps (50 lumens per watt) have improved nearly 50 per cent, besides providing for better colour rendering, and tubular fluorescent lamps (60 lumens per watt), an immediate pre-war development, have improved 65 per cent in the past 15 years. Concurrently lamp life has been extended and the operating technique of public lighting has advanced so that inspection and maintenance costs are now a lower proportion of the total.

Generally speaking, to-day's total costs (including capital repayments) average about 4d. per week per householder, less than a box of matches per person per week. Over the 25 years, the cost per ratepayer per annum has about

doubled (from 10s. to 20s.)—less than required to compensate for monetary devaluation alone whilst, on the average, providing about three times more light per lamp position. The present day annual cost for each street lamp (average for all roads) is about £7.3 (£3.5 energy, £3.8 maintenance) compared with £4.5 (£2.3 energy, £2.2 maintenance) and the cost per lumen per annum is about ¼d. compared with over ¾d. in 1936. Allowing for the change in the purchasing power of money, today's costs are therefore less than one-quarter of those 25 years ago.

The Ultimate Aim

A full lighting service throughout the whole of the hours of darkness should surely be the prime object of public lighting, and yet fulfilment of this aim is slow. When costs were high there was a natural reluctance to operate more lamps all night than absolutely necessary for bare coverage; but the situation has changed, and yet only a few progressive authorities have adopted full dusk to dawn lighting, or use multi-lamp lanterns on dual lighting periods. In fact, more than 50 per cent of the lamps in the country are evening lamps (dusk to about midnight). Much of the capital expended, £50/£75 per lamp (Gr.B/Gr.A), is therefore used for only a few hours each night, whilst the extra cost for an all night lamp is about £1.5/£3 (Gr.B/Gr.A). The extra safety and convenience to the public would surely warrant the small additional expenditure, generally about 10 per cent of the annual public lighting budget, amounting to only about 1s. 9d. per year per citizen. Such a move would greatly assist police patrols (important when police forces are short staffed), help to prevent crimes of burglary and assault and make safer the parking of cars without lights, whilst generally providing a more comforting atmosphere on cheerless dark nights.

In 1936, road accidents were costing the country about £60 million annually whereas by 1959 this had risen to £219 million. Road vehicles have increased from 2.76 million to 9.38 million in 1960 and the number of accidents has risen from 234,374 to 271,787 in the respective years. The nation cannot afford to be satisfied whilst human suffering and this needless waste of money and time continues. At least a 30 per cent all round reduction in night-time personal injury accidents can be expected when a good modern street lighting installation replaces a poor one. More expenditure on better public lighting is therefore fuily justified whilst vehicular traffic, and the inevitable accident rate, continues to increase.

Reorganization of Control

Reorganization of the administrative control of public lighting was first mooted in the late 1930's. There were, as now, about 3,500 lighting authorities operating in the country, of which it was thought that over 75 per cent controlled too few lamps to provide efficient and economical working units. Large lighting units are able to solve the financial problems of providing and maintaining adequate street lighting installations, but it is quite impossible for many of the smaller lighting authorities to do so. Ineffective lighting on main through roads carrying heavy traffic, which pass through such areas, is a danger. Consultative Committees have been set up to enccurage voluntary co-operation and co-ordination on lighting matters between the various authorities in conurbations, but a street lighting service must provide for the safety and comfort of all road users and, therefore, the financing of at least main road lighting should become a national charge. A form of grant system could operate, but administrative and operational control should be retained at local, or regional, level. Economic operation of this public service is essential and proper, frequently costly, equipment has to be available, which should be centred on units of sufficient size for operational efficiency, capable of economical buying and able to employ the services of qualified specialist staffs.

In the last few years there have been many misguided demands for uniformity in street lighting. Proper liaison and planning can achieve a standard level of illumination on through roads, and avoid the undesirable frequent changes of colour, without the restrictive influences inherent in any form of standardization. Experienced lighting engineers should always be free to select the most efficient installation best suited to the community and locality. Surely variety is interesting and avoids dangers from monotony and boredom.

Future Propositions

The 30/35 ft., and even 40 ft. mounting heights being installed today were, 25 years ago, a fantasy of the future; now, thanks to the adaptability of manufacturers of columns and maintenance equipment, it is a practical proposition for main road lighting and will become commonplace in the next decade or so. This new development should enable better spacing/height ratios to be used and thereby provide more effective street lighting installations, which have less glare and a more uniform light pattern to cater for the modern road surfaces.

Lighting in Paisley (*Concluded from page* 367).

since equipment has to be capable of surviving damage or destruction due to inclement weather conditions. It has to be made safe for the road users and as far as possible immune to damage by vandalism. It has to be efficient and economical in operation and the equipment so far as it is possible must be pleasant to the eye in day-time.

Today, when road development is contemplated, the most modern type of illumination is installed and where central islands are built twin-headed fluorescent lanterns are used. By doing this the footpaths are left free from obstructions. At the moment Paisley is the only town where fluorescent lighting has been used to such an extent, since very few tungsten filament lamps remain. Where heavy traffic prevails, such as in bus routes, 250 watt high pressure mercury lamps are used and most of these routes have now been completed. Much street furniture assisting manoeuvres has been erected by the Burgh Engineer such as advance road signs, etc. and most of them are connected to the public lighting network.

Although the latest types of street lighting units are used, an eye has been kept on economy and this is shown by the fact that if conversion to mercury and sodium had not been undertaken from 1958 till the present time the total load would have now been 1,150 kilowatts, or approximately £27,000 per annum for electrical energy. The load is at present 760 kilowatts costing some £21,000, therefore the balance of £6,000 per annum can be utilized to pay off the loan charges and offset the resultant higher cost of the more efficient types of lighting equipment. Paisley Lighting Department is the second largest electricity consumer in Paisley.

The present approximate value of the street lighting equipment is in my opinion in the region of £250,000 while the replacement value, if that were necessary, would amount to about £750,000. There are now over 4,500 street lamps and over 10,000 stair lamps within the Burgh and the total illumination emitted from all these lamps amounts to approximately 17 million candle power.

As to the future of street lighting in Paisley, my own opinion is that mercury lamps in some form or other will be used and the colour rendering of such lamps will be improved until they emit light within the perfect spectrum. Sodium lamps will only be used near the perimeter of the Burgh and on roads where no shopping centres of any size exist. There appears to be no possibility at this moment of improving the colour of this light, therefore I feel it would be foolish to use it in town centres. Unfortunately, this practice is being carried out elsewhere. I also feel that the erection of fittings vertically on the faces of property results in a great loss of light in the upper hemisphere and is therefore uneconomical.

The present accepted mounting height of 25 ft. in Class A roads may be raised to 30 ft. and even 35 ft., but again complications may arise while economy is impaired due to the greater amount of light required.

The high pressure mercury amps, as used in Paisley, have a useful life of 5,000 hours, but from the moment they are put into commission until the end of their useful life the light output will have decreased by approximately 15 to 20 per cent and this situation appears to have been accepted by the manufacturers as normal.

During the past two years experiments with lamps have been carried out in Paisley it has been found that by operating such lamps in an unorthodox manner their life can be extended to 12,000 hours or three years burning without failure and without decrease in light output. These results have been found to be contrary to the belief of the manufacturers. In Paisley, 1,000 lamps are operated in this manner at present and the results are satisfactory.

PROFILE

STUART MAYNARD LOVELL

STUART Maynard Lovell was born in Cheddar, Somerset, the son of a Devonshire man who was a civil engineer and of a mother who came from a long line of yeoman farmers. At an early age he was sent by his father to be an articled pupil under Colonel Stead, the then County Engineer and Surveyor of Somerset.

Today, this youthful, robust looking 52-year old man, is a Colonel R.E., an O.B.E., T.D., and as Chief Engineer and County Surveyor of West Riding, is responsible for an area of 1,625,058 acres with a population of over three million people.

To him is due much of the credit for the successful completion of the new Doncaster Motorway, recently opened by the Rt. Hon. Ernest Marples, Minister of Transport. This magnificent engineering feat took some four years to complete and cost £6 million. The 15 miles of motorway that lies in West Riding will ultimately connect with the London - Yorkshire Motorway, thus opening up and completing a 27 mile long westward diversion of the Great North Road. Much of the roadway had to be taken over ground which had been almost completely undermined by coal workings, and the authorities expect that subsidences will be as much as 14 ft. during the next 20 years, but at the same time, nearly three million cubic yards had to be blasted out of the intractable limestone rock.

There are more than 30 bridges, comprising six main types: four-span, single-span, railway and foot bridges, slender cantilever bridges, and the major bridge over the River Don. There are also innumerable culverts and subways. The maintenance problems connected with a road engineering project of this complexity, are largely the responsibility of Stuart Maynard Lovell, one time pupil of Colonel Stead. Of him he said:

> 'Colonel Stead was a truly wonderful man, he taught me everything. I don't think that many young engineers could have had the advantages I had under this man. By the time I was 30, he had made it possible for me to have acquired a sound working knowledge of all aspects of civil and municipal engineering. I had worked in each and every section and on all types of projects, including road planning engineering and construction'.

In 1939 Stuart Maynard Lovell found himself in uniform, in the Royal Corps of Engineers. In 1941 he was attached to the British Military Mission in Moscow and has this to say of the Russians:

> 'I liked the Russians when one could meet them outside the official circles, they were a friendly crowd. I gained the impression that as a people they were fighting for Mother Russia, and not for any "ism" whatsoever.'

He then saw service in North Africa and Italy. In 1944, after the fighting was over, he was Commander R.E. at Taranto in the heel of Italy. Returning to England in 1945 he resumed his work in Somerset, but left within a few months to become Chief Engineer and Surveyor of Pembrokeshire.

In 1947 he took a big decision:

> 'I demoted myself,' said Col. Lovell, 'by going as Deputy Chief Engineer to West Riding. Within two years I took over my present post. I am really very happy in Yorkshire, for as an engineer one has a fascinating view of the problems facing such a concentration of industrial wealth. We have the bulk of the steel works, textile factories and coal mines in West Riding.'

His working headquarters are at Wakefield, but of them he said:

> 'We live however, in the beautiful little village of Collingham, near Wharfe. My wife, Anne, is a Londoner, but she loves the country. One son is already in business, and the younger boy is concentrating on getting his Honour's Degree in Chemical Engineering.'

As he put on his glasses, he confessed that he did not do anything spectacular in the way of recreation. but that he used to play golf, but now concentrated on gardening, and was still interested in soldiering and went to camp sometimes because the T.A. Command still seemed to have some use for him.

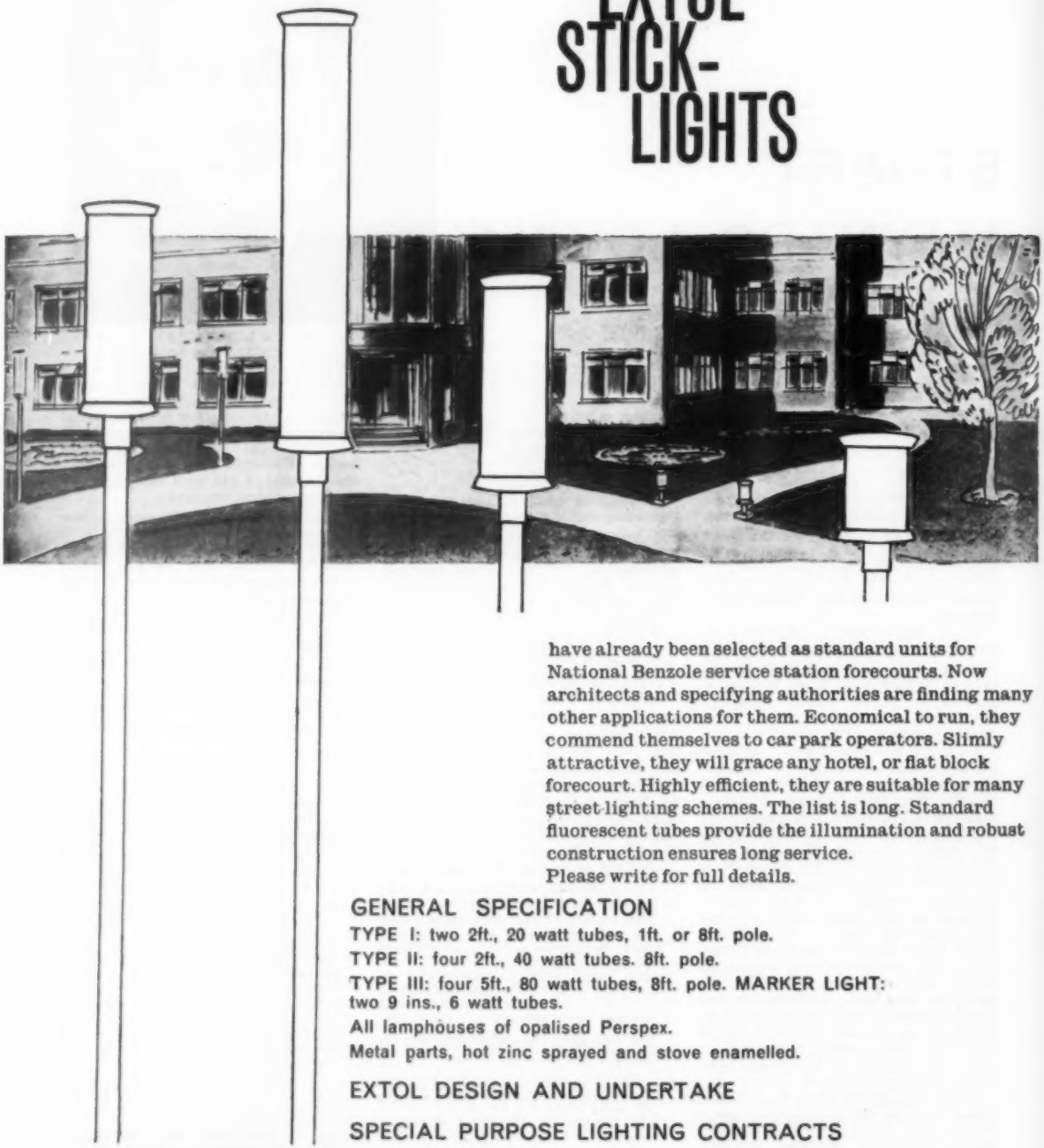
Some six feet of masculinity, blue-eyed, clean shaven and with a tanned outdoor look about him, Col. Lovell could well be taken for a big game hunter or a world class yachtsman but, as he speaks of his work and methods, the man of ideas emerges:

> 'An engineer has a tidy mind, he has simply got to have, for his work and training instil this sense of order into all his thinking.'

A Member of the Institution of Civil Engineers, a Fellow of the Town Planning Institution and an Associate Member of the Institution of Municipal Engineers, Col. Lovell is often called upon to examine papers, write articles and attend meetings for these various bodies. Recently, a meeting examined the relationship that exists between engineers and management and here is his view:

> 'I think that the young engineers could do much more than they are doing in management today. Engineers perhaps do tend to become restricted within their specialized fields, but it is precisely the tidy mind of the engineer that would be of most value in management as such. It was perhaps this instinct for order, that led me to experiment in my early days in Somerset, with various methods of traffic control. speed limits and traffic lanes. For example, I used different coloured chippings in road surfaces, in order to get a system of demarcation that the motorist could quickly grasp. A white surface, or a black surface, and various colours, could mean various speed limits Today this is quite common, but then it was not, and there were by no means all the aids to traffic control such as white lines, catseyes and so forth.'
>
> 'But that is old history, it is the future that is going to make the greatest demands upon our engineers. In the North of England we have probably the greatest road programme ever planned by any government in this country for the past 50 years. The biggest individual programme that is, and for my part I feel very fortunate to be in a position to meet this challenge. I am speaking of the great motorways planned latitudinally over the Pennines and longitudinally from Sheffield to Leeds and eventually right through to Newcastle. The Doncaster Motorway is only a beginning. For the next 10 years I can see my work ahead of me, and I realize that I am very fortunate indeed to have such an opportunity.'

EXTOL STICK-LIGHTS



have already been selected as standard units for National Benzole service station forecourts. Now architects and specifying authorities are finding many other applications for them. Economical to run, they commend themselves to car park operators. Slimly attractive, they will grace any hotel, or flat block forecourt. Highly efficient, they are suitable for many street lighting schemes. The list is long. Standard fluorescent tubes provide the illumination and robust construction ensures long service.
Please write for full details.

GENERAL SPECIFICATION

TYPE I: two 2ft., 20 watt tubes, 1ft. or 8ft. pole.

TYPE II: four 2ft., 40 watt tubes. 8ft. pole.

TYPE III: four 5ft., 80 watt tubes, 8ft. pole. MARKER LIGHT: two 9 ins., 6 watt tubes.

All lamphouses of opalised Perspex.

Metal parts, hot zinc sprayed and stove enamelled.

EXTOL DESIGN AND UNDERTAKE

SPECIAL PURPOSE LIGHTING CONTRACTS

EXTOL ENGINEERING LIMITED

Park Road, High Barnet, Herts. Telephone: BARnet 1051 (5 lines)

THE DESIGN AND MANUFACTURING DIVISION OF THE EXTOL ENGINEERING GROUP

A.P.L.E. EXHIBITION - SCARBOROUGH

THIS Exhibition, staged for the Association of Public Lighting Engineers' Conference at Scarborough from October 3 to 6 contains some very interesting stands. A great many new models are shown alongside the well-known and established equipment. Unfortunately it is not possible to give the fullest details of all the stands in these pages, but a selection of the exhibits has been made while further details of all items shown are available.

The following manufacturers, amongst many others, have stands at this Exhibition.

The General Electric Co. Ltd.

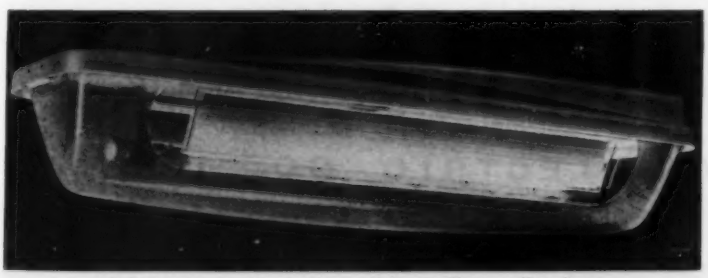
The Lighting and Heating Group of the General Electric Co. Ltd., is showing a selection from its large range of equipment which reflects the trends towards higher levels of illumination in street lighting installations. Parallel to the problems of providing more light without the discomfort of increased glare, has been the introduction of new non-skid road surfaces with very low reflection properties. During the past year G.E.C. lighting engineers have been actively engaged on these problems and the theme of this year's stand demonstrates the results of some of this research.

Typical of the newest developments are the lanterns for main road lighting using Osram colour corrected mercury lamps. One of these is a lantern having a true cut-off distribution in accordance with the B.S. Code of Practice. Another houses a line of three colour corrected Osram mercury lamps. A post top lantern for high mounting heights and housing Osram mercury lamps is also shown. New approaches to the problem of providing high levels of illumination in sodium street lighting installations are apparent in two high efficiency lanterns in both cut-off and non cut-off versions, using the Osram 200 watt linear sodium lamp. New lanterns for side road lighting are displayed. These include a lantern for two 2 ft. 40 watt Osram fluorescent tubes, two lanterns for Osram 60 watt sodium lamps, in both cut-off and aeroscreened forms and post top lantern for Osram tungsten filament or mercury lamps.

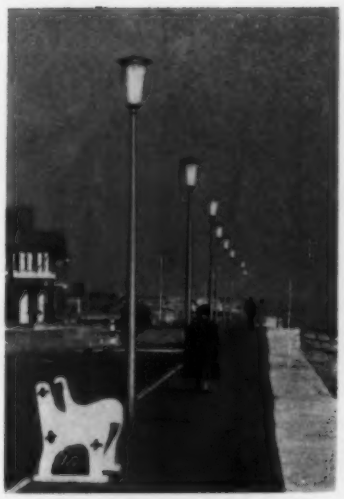
In the outdoor section there is a selection of G.E.C. street lighting columns made in both steel and concrete, and—for the first time—a reinforced plastic column.

T.E.C. 230 for further details

G.E.C. lantern having a true cut-off distribution in accordance with B.S. Code of Practice.



G.E.C. lantern using the Osram 200 watt linear sodium lamp.



Aluminium lighting columns made by Metal Developments (1960) Ltd.

Metal Developments (1960) Ltd.

Metal Developments (1960) Ltd. are exhibiting 10 aluminium alloy lighting columns: two Group 'A' and eight Group 'B' showing a few of the possible variations of finish obtainable with these columns, and various combinations of columns and lantern. The specific advantages of using aluminium street lighting columns are claimed by the makers to include the following.

The average weight of a Group 'B' column manufactured from aluminium is 35 lb., therefore, not only is it unnecessary to use expensive lifting tackle, it is also possible for the erection to be carried out by one man. This has the additional advantage of reducing obstruction and interference with traffic in busy streets.

The alloy used in the manufacture of lighting columns was chosen after extensive tests by both Metal Developments (1960) Ltd. and the British Aluminium Co. Ltd. It is claimed that the alloy's corrosive resistant properties made it eminently suitable for use in both industrial and marine atmospheres. Columns erected for several years in even the most aggressive industrial atmospheres have shown, the makers have asserted, no evidence of surface damage, thereby eliminating the re-current expense of re-painting.

T.E.C. 231 for further details

TEC649 for further information

REVO

lighting goes to the front

Photo by kind permission of C. Anderson, M.I.E.E., M.Inst.F., Borough Electrical Engineer and Manager, Douglas Coporation Electrical Dept.

The impressive two mile long sweep of Douglas, Isle of Man promenade is shown here brilliantly illuminated by Revo Helion lanterns (shown top left) specially developed for this scheme.

Lighting the promenade of a seaside resort involves a number of problems not usually encountered in normal street lighting. The road surface must be exceptionally well illuminated especially during the holiday period. True colour representation is most important. A bright spectacle must be provided without detracting from the effect of other purely decorative lighting. The lanterns must be decorative both when lighted and during daylight and must withstand the effects of storms and sea spray. During the winter provision for the reduction of the lighting to normal standards must be made. All these conditions have been satisfied by the Revo installation at Douglas and has received widespread approval from residents and visitors.

REVO ELECTRIC CO. LTD.,
TIPTON, STAFFORDSHIRE

W & W

Alf'd Miles Ltd.

Four light alloy lighting columns, manufactured by Alf'd Miles Ltd.—a member of the Hawker Siddeley Group—are to be exhibited on Site No. 1 in the Outdoor Display in the Spa Access Road.

Three Group 'B' Type 9 columns, and one Group 'A' Type 9 column, are to be shown. The 25 ft. column is to be fitted with an Atlas Alpha Three lantern, the 15 ft. columns with an Atlas Gamma lantern (as fitted to the Miles columns installed in the new multi-storey car park at Torquay), an Eleco post-top lantern (as at Ilford), and a Siemens lantern (as used by the Stevenage Development Corporation).

The material used in the manufacture of the lightweight Miles columns—the 15 ft. columns weigh only 35 lb.—is B.S. 1470 N.S.5, which has a very high corrosion resistance, increased by the sand-blast finish.

T.E.C. 232 for further details

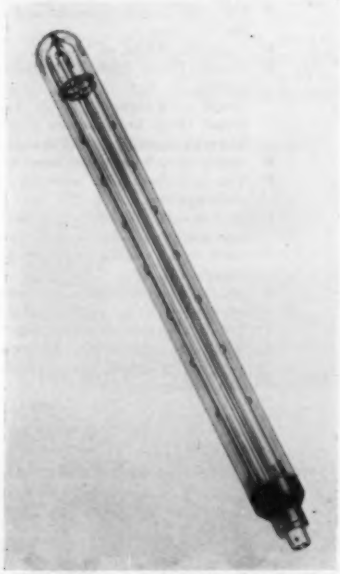
Philips Electric Ltd.

The emphasis on the Philips stand is strongly on two types of light source: sodium lamps, for traffic routes and floodlighting, and mercury fluorescent (colour-corrected mercury) lamps, which combine high efficiency and good colour quality.

Among the sodium types, the full range of integral lamps is on show, with special stress on the 200 watt SOI/H which has an average-through-life light output of 20,000 lumens.

Mercury fluorescent lamps are shown both with and without internal reflectors (types MBFR/U and MBF/U respectively). Sectionalized phosphor coatings enable visitors to examine the special internal construction of this range of lamps, which now extends from 50 watts to 2,000.

The differences in the red content and efficiency of the MA/V, MB/U and MBF/U mercury types are shown in a demonstration in which a rotating barber's pole has different parts of its length illuminated by these three sources.



The 200 watt SOI/H Sodium Lamp.

The apparatus on show includes the full range of polyester-filled ballasts for discharge and fluorescent lamps. There is a new family of extra-high quality capacitors for streetlighting, and a special demonstration of transistorized ballasts which permit standard fluorescent lamps to be run from the low voltage D.C. available in motor vehicles.

T.E.C. 233 for further details

Poles Ltd.

The display of ten columns at Scarborough include examples of sectional and one piece columns from 35 ft. mounting height down to 12 ft. Adastra sectional columns are available for mounting up to 60 ft. heights or more, if desired. Of particular note are the recent designs for Group 'B', of which aluminium columns can be supplied as alternatives to galvanized steel when large quantities are involved. Floodlight supports in tubular steel or latticed steel designs are produced by the Company and an example of the tubular type is also installed on the outside display ground.

On the indoor stand are miniature scale models of some of the Company's lighting products.

T.E.C. 234 for further details

Sangamo Weston Ltd.

On this stand a selection from the range of Sangamo time switches for street lighting will be shown. These include single pole, single throw models with solar dial giving operations at sunset and sunrise. Another model allows a fixed off operation between the times of 8.30 p.m. and 1 a.m. and a fixed on operation between the hours 3.15 a.m. and 8.45 p.m., thus lights controlled by this switch come on at dusk regardless of the time of year, switch off at say midnight and, during the winter months, switch on again in the early morning at a fixed time each day, finally switching off at sunrise.

Models for use with multiple lamp lanterns will be on display as well as spring reserve models which are synchronously controlled when the current is on and have a reserve of at least 24 hours in the event of interruption of supply. Examples from the range of Sangamo Watthour meters and accessories will also be shown as well as Weston electrical measuring instruments.

T.E.C. 235 for further details

The 12D Spun Concrete column by Stanton and Staveley Sales Ltd.

Stanton and Staveley Sales Ltd.

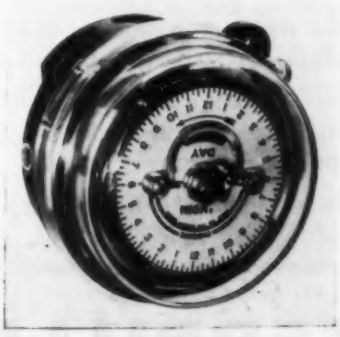
The distinctive range of column designs based on the Type 8 has been further extended by the inclusion of Types 12D and 12F for both 30 ft. and 35 ft. mounting height. These are supplied with concrete brackets and have been accepted for inclusion in the Council of Industrial Design approved list.

The following columns will be exhibited on the Spa Access Road, the area allotted for the outdoor exhibition.

Type 8F with Revo Horizon lantern.
Type 8G with Wardle Aureole lanterns.
Type 8 with A.E.I. SL.3521 lantern.
Type 10 with G.E.C. Z.8449C lantern.
Type 10F with Revo C.15152 lantern.
Type 10K with Atlas Beta III lantern.
Type 11 with Revo Hyperion lantern.
Type 12D, 30 ft. M.H. with G.E.C. Z.9500 lantern.
Type 12F, 35 ft. M.H. with Atlas Alpha V lantern.

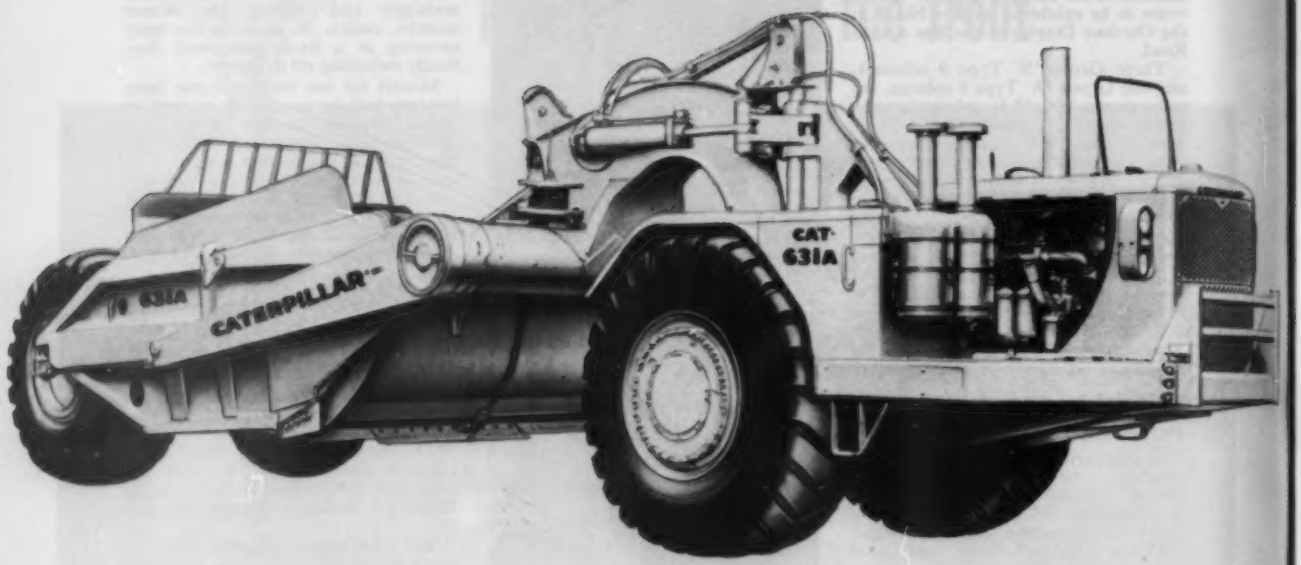
It is now 10 years since Stanton exhibited the first prestressed columns for Group 'A' lighting. The advantages of this method of construction, particularly in the ability of the column to withstand the stresses of handling and erection, were quickly realized and it has been possible to concentrate almost exclusively on production of the prestressed column. Normally reinforced columns are, however, still available in certain types.

T.E.C. 236 for further details



A Sangamo Time switch.

WATCH THE **631A** DO **BIG** THINGS FOR YOU!



SEE THESE OUTSTANDING **CAT** FEATURES!

1 Watch the 631A's high-performance Caterpillar Diesel Engine with 420 H.P. (Max.) Improved design features, such as controlled turbocharger with after-cooler, twin overhead camshafts, better manifolding and breathing characteristics give the 631A new power – more power – for higher production.

2 Watch the Power Shift Transmission – designed expressly for wheel tractors, make gear or direction shifts without loss of power. 9 forward speeds (Max. 31.2 mph) and 3 reverse speeds plus loading range are available from the automatic power selection and exclusive torque divider system.

3 Watch the 631A's Lowbowl design scraper move more dirt, more quickly at less cost – heaped capacity 28 cu. yd.

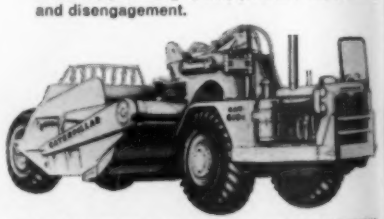
4 Watch the constant power air actuated cable control system cutting operator fatigue by 50%, maintaining operator efficiency at peak, right through the day.

5 Watch improved accessibility for servicing – unit construction, swing-away dash and crankcase guard.

6 Watch these other 631A features cut costs, boost efficiency. Specially developed wide base 29.5 x 35 tyres, greater braking capacity, improved steering, Torsionflex seat and in-seat starting.

Also available
619C WHEEL TRACTOR-SCRAPER
The high-speed tractor-scraper with these outstanding features:

- Cat after-cooled turbocharged diesel engine - 280 H.P. (Max.)
- Capacity – 18 cu. yd. heaped.
- Proven Power Shift Transmission giving three speeds in each of three ranges plus loading range . . . 9 forward speeds, 3 reverse. 6-speed Direct Drive transmission also available. Both transmissions give travel speeds over 30 m.p.h.
- Faster cycle times equal lower cost per yard.
- Two-jack hydraulic steering facilitates easy manoeuvring.
- Unmatched accessibility: unit construction, planetary final drive and swing-away dash features make overall servicing both simple and speedy.
- Operator ease: refinements such as Torsionflex seat, cable-saver and air-actuated clutch (on Direct Drive model) are standard equipment.
- New cable control, with 'live' power, air actuated controls, providing quick, positive engagement and disengagement.



CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

THE POWER FOR GREATER PRODUCTION

CATERPILLAR TRACTOR CO. LTD. GLASGOW LEICESTER NEWCASTLE LONDON TRACTORS · EARTHMOVING EQUIPMENT · ENGINES · PARTS
Registered User of Trademarks Caterpillar and Cat

INDUSTRIAL NEWS and INFORMATION

New Plant Hire Depot

Eddison Plant Ltd. announce the opening of a new depot at Holywells Road, Ipswich. This firm, whose head office and main works are at Belton, near Grantham, is the oldest plant hire organization in Britain and maintains the world's largest fleet of rollers for hire and a wide range of contractors' plant.

The importance of supplying plant promptly to Local Authorities and contractors throughout the country is recognized by this company who maintain their service through 16 depots in addition to this new one at Ipswich. As with the previously opened depots, Ipswich will be under the personal supervision of the Area Representative, Mr. G. E. Lovell, while the overall control of the Eastern Counties Area remains under Mr. R. L. Francis. The plant available includes:

Eddimatic Torque Ranger diesel road rollers. (8/13 *tons*).
Aveling-Barford road and footpath roller (30 *cwt.*/12 *tons*).
Stothert & Pitt pedestrian operated and tandem vibrating rollers.
Broomwade portable diesel-engined compressors (2/13 *tools*).
International and Case tractor shovels (1 & 1½ *cu. yd.*).
Barford dumpers (½, 1½ & 4½ *cu. yd.*)
J.C.B.4. hydraulic excavators.

Experienced mobile service engineers, who are available day and night to give immediate attention to any item of plant, ensure its continuous satisfactory operation. Skilled operators are available for all mobile plant, and a varied fleet of transport vehicles up to 25 tons capacity ensure prompt delivery direct to the site.

T.E.C. 237 for further details

The newly opened depot at Ipswich of Edison Plant Ltd.

The Modified Barrier made by R. B. Pullin Ltd.

Cheaper Latex for Roads

An important technical advance of interest to roads authorities is reported by the National Rubber Bureau. Hitherto liquid latex has been difficult to use as an additive to road surfacings because it causes foaming, owing to its high water content, when added to the hot bitumen in the boiler. This problem has now been solved by the use of a technique in which the latex is dispersed finely in the fluxing oil before mixing with the bitumen. Another advantage of the new method of latex addition is that the blending temperature is kept to below 120-130°C. and the rubber remains in its most effective form. Thus, less rubber can be used and a reduction in the price of the rubberized binder achieved.

T.E.C. 238 for further details

Traffic Control Barrier

A number of modifications have recently been made to the Pullin traffic control barrier.

The barrier, which is primarily for controlling traffic on factory roads and car park entrances, is made of a light tubular alloy fabricated with an arm of any length of up to 16 ft. 4 in. It is raised or lowered by an electric motor and is supported in a substantial main frame. When several barriers are being used in conjunction, they can be remotely controlled from a panel which provides automatic interlocking.

Optional extras have recently been incorporated including pigmy lights with 12 watt lamps on each stop sign and a signal lamp at the end of the arm. The barrier is now powered by a ¼ h.p. geared motor, the ratio reduced from 7:1 to 4:1. This new ratio helps to ensure that there is no vibration when the arm reaches its upper or lower limits. Motor and gearbox are totally enclosed and the barrier is driven from the gearbox by chain and sprocket via a friction clutch. Clutch torque is set so that it is only just sufficient to raise the barrier preventing damage to the gearbox if the arm is forced by an impact when between its limits of travel.

T.E.C. 239 for further details

Please use the prepaid cards for the Reader Information Service. For further details of items mentioned in this journal, complete and return the card to us.

TEC651 for further information

SANGAMO

Time Switches for lighting control

Long-term reliability

SOLAR DIAL SWITCH

In every sphere experience has shown that there is a place for the product which is "just a little better" both in design and in construction. In Time Switches that place is filled by the SANGAMO range—manufactured with finest engineering precision not only to function accurately NOW but to go on giving faithful service almost indefinitely. Advice and particulars of the entire range of Sangamo synchronous Time Switches will gladly be supplied on application.

SANGAMO WESTON

SANGAMO WESTON LIMITED · ENFIELD · MIDDLESEX

Tel: Enfield 3434 (6 lines) & 1242 (6 lines). Grams: Sanwest, Enfield. Scottish Factory: Port Glasgow, Renfrewshire

Branches: London · Glasgow · Manchester · Newcastle-on-Tyne · Leeds · Liverpool · Wolverhampton · Birmingham · Nottingham · Bristol · Southampton

sw/7

For DIVERSIONS and other TEMPORARY SIGNS

*The ECON Traffic Beacon**

Crisp Flash
Easily Fixed
Thief Resistant

Robust Design
Weatherproof
28 Days Life on one Battery

**Flashing beacons are approved under the Traffic Signs Regulations Statutory Instruments No. 1095/1960*

THE ECON LAMP COMPANY
166 DIXONS HILL RD., NORTH MYMMS, HATFIELD, HERTS.
Telephone : Hatfield 2147

MAIN DISTRIBUTORS FOR THE MIDLANDS AND NORTH OF ENGLAND
Alexander Kenyon & Co. Ltd
AKENCO HOUSE, ELIZABETH STREET, MANCHESTER, 8
Telephone : Broughton 4211 (10 lines). Wire: Everything, Manchester.

TEC652 for further information

sw/7

r 1961